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CONTENTS.

	PAGE
Wireless Telegraphy. By G. W. DE TUNZELMANN, B.SC. (*Illustrated*)	25
The Evolution of Simple Societies. By Prof. ALFRED C. HADDON, M.A., D.SC., F.R.S.	29
Polarity in Magic Squares.—I. By E. D. LITTLE. (*Illustrated*)	31
The Fly "Syritta Pipiens." By WALTER WESCHÉ. (*Illustrated*)	33
Photograph of the Trifid Nebula ♅ IV. 41 Sagittarii, and of the Region Surrounding. By ISAAC ROBERTS, D.SC., F.R.S. (*Plate*)	35
Astronomy and Astrology: A Question of Primogeniture. By E. WALTER MAUNDER, F.R.A.S.	35
Letters:	
IS THE UNIVERSE INFINITE? By W. H. S. MONCK ...	38
LUNAR SEAS. By A. ELVINS	38
S. S. CYGNI. By DAVID FLANERY	39
Obituary:	
JOHN RUSKIN	39
Dr. ELLIOTT COUES	39
Notices of Books	39
BOOKS RECEIVED	40
British Ornithological Notes. Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.	41
The Buried Alps. By GRENVILLE A. J. COLE, M.R.I.A., F.G.S. (*Illustrated*)	41
Long Waves of Winter Weather. By ALEX. MCDOWALL, M.A. (*Illustrated*)	44
Microscopy. By JOHN H. COOKE, F.L.S., F.G.S. (*Illustrated*)	45
Notes on Comets and Meteors. By W. F. DENNING, F.R.A.S.	46
The Face of the Sky for February. By A. FOWLER, F.R.A.S.	47
Chess Column. By C. D. LOCOCK, B.A.	47

WIRELESS TELEGRAPHY.

By G. W. DE TUNZELMANN, B.Sc.

IN the ordinary commercial system of telegraphy, signals are transmitted between two distant stations by means of electric currents made to flow through a circuit consisting of an insulated wire connecting the two stations and the earth. The wire being connected with the earth, or "earthed," as the telegraphist expresses it, at each of the stations in order to make a complete circuit or loop round which the electric flow takes place.

When a new system of sending electric signals in which no connecting wire was required between the two stations came into prominence it was named from the most striking features to the ordinary observer, namely the absence of the connecting wire.

The name is not logically defensible, for on the one hand the method of signalling known as "Wireless Telegraphy" involves the use of wires both in the transmitting and in the receiving apparatus, and on the other hand it includes systems of signalling which are not popularly supposed to be electrical at all.

The term ætheric telegraphy, which has also been suggested, is just as open to the latter objection as the one in common use, and personally I should be inclined to suggest the term Hertz Wave Telegraphy or Hertzian Telegraphy, for the system of telegraphing without connecting wires which is now exciting so much interest and attention. Though greatly developed by the researches of Lodge, Marconi, and others, Hertzian telegraphy depends entirely upon exciting at the transmitting station and detecting at a distant receiving station æther waves of a certain character, the existence of which had been deduced theoretically by Professor Clerk Maxwell, but first experimentally demonstrated by the late Dr. Hertz, of Carlsruhe, who published the results in a series of papers in "Wiedemann's Annalen" beginning in July, 1887.

It has long been an admitted fact that the observed phenomena of light can only be explained by the existence of a highly elastic medium, to which the name of luminiferous æther has been given, and which must fill at any rate the whole of the space into which our vision can penetrate, that is to say the space intervening between the earth and the most distant visible stars.

The phenomena of light show, that for extremely rapid motions such as light waves, which traverse some 186,000 miles in a second, this medium is far more rigid than steel, while for comparatively slow motions such as those of the planets (the earth's speed in its journey round the sun is considerably under 20 miles a second), it offers so little resistance that in most cases it is imperceptible to us. In the case of Encke's comet astronomers believe they can just detect evidence of the existence of a resisting medium in space, but that is all.

If any reader is disposed to object to the assumption of a medium behaving in such very different ways with regard to motions of different speeds, it may assist in convincing him that the objection is not a valid one, to direct his attention to the similar behaviour of such a familiar substance as pitch. In moderately cold weather this material has all the appearance of a solid, and will resist a blow or momentary heavy pressure. If, however, a denser body than the pitch, such as a bullet for example, be laid upon its surface, it will gradually sink until it rests upon whatever is supporting the pitch. If on the other hand the pitch is placed upon a less dense body, such as cork, the latter will float up through it in the course of time. The pitch, therefore, exposes great resistance to rapid motion, but the smallest pressure causes it to give way if sufficient time is given, or, in other words, when the motion slows down sufficiently the resistance becomes negligeable, thus offering very close analogy to the behaviour of the luminiferous æther.

When a disturbance is set up in a medium, waves are in general emitted in all directions from the point of disturbance. Sound we know is transmitted by air, and, unlike light, it will not traverse what we call empty space, viz.:—space occupied only by æther.

Now, air and other gases are composed of molecules in an irregular condition of agitation, which can be shown to explain the observed fact that sound is transmitted through air entirely by longitudinal vibrations, that is to say, by waves in which the portions of the vibrating medium move backwards and forwards in a direction parallel to that in which the wave is travelling. Vibrations in other directions are necessarily started by the disturbance which gives rise to

the sound, but it is found that the transverse vibrations die away almost immediately. Clerk Maxwell points out that, within a single wave length, the amplitude of the transverse vibrations will be reduced to less than one-five-hundredth of its initial value owing to this state of irregular agitation.

In the case of light, on the other hand, it is found that transverse vibrations are the only ones which are transmitted, that is to say, that all vibrations along the line in which the wave is travelling die away almost immediately, so that the vibrations are entirely perpendicular to the line of transmission. The reason of this had never been explained until Maxwell showed, from electromagnetic theory, that electric waves must have this characteristic. This suggested to him the hypothesis, that light waves were simply electric waves, of such wave lengths as to be capable of affecting the receiving instrument commonly known as the eye.

Many phenomena when investigated were found to confirm this hypothesis; the close correspondence, for example, between the calculated speed of transmission of an electromagnetic wave and the observed velocity of light; and, again, the fact that transparent substances are invariably bad conductors of electricity.

Hertz, however, made a step further, for, as we shall see, he succeeded in producing waves known to be of electro-magnetic origin, and in showing that they could be made to produce interference phenomena and undergo reflection and refraction exactly like light waves.

When oscillations are set up in an electric circuit it can be shown that the time, T, of a complete oscillation is determined by the equation

$$T = 2\pi \sqrt{L, S},$$

where L and S are two of the electric constants of the circuit known as its self induction and its capacity respectively, while of course π stands as usual for the ratio of the circumference of a circle to its diameter, which is approximately equal to 22/7.

The speed with which the waves travel, depends only on the medium being equal to the square root of the ratio of its elasticity to its density. In the case of the æther this speed is about 186,000 miles a second, the observed speed of light.

We will now consider the question as to what kind of æther waves are most suitable for the transmission of signals to a distance.

The conditions to be fulfilled are clearly two in number. Firstly, in order that the waves may not be stopped by intervening obstacles, such as portions of land and water, we require oscillations for which the opacity of different kinds of matter is least, or, in other words, those oscillations for which ordinary terrestrial bodies are most transparent.

Secondly, in order that the signals may be distinguishable at as great distances as possible with a moderate expenditure of energy, we require those oscillations for which the largest possible proportion of the energy supplied from the source, the transmitting instrument may be taken up by the medium.

We know that ordinary light waves, the wave lengths of which are measured in hundred-thousandths of an inch, fulfil the second condition in the most satisfactory manner, but unfortunately they do not fulfil the first, for the thinnest films of most substances are sufficient to stop them. Still, they were employed for the earliest attempts at wireless telegraphy, which is far more ancient than the system of telegraphing by means of wires. In the earliest examples of which we have any record, the requisite æthereal oscillations were excited by means of large bonfires, and the difficulty of fulfilling the second condition was evaded by placing both the transmitting instrument consisting of the bonfire, and the receiving instrument, which was simply the eye of the watchman, on the highest hills available, so that the waves excited had only to encounter the comparatively transparent atmosphere. The semaphore of a hundred years ago and the heliograph of to-day offer further examples of wireless telegraphy by means of electric oscillations of extremely short wave length.

All bodies become less opaque to electric bodies as the wave length increases. The reason of this, according to theory, is that the quenching of the waves does not take place immediately on entering any opaque medium, as would be the case if it were a perfect conductor of electricity, but the waves die out after a certain number of vibrations depending on the opacity of the medium.

It is clear, therefore, that in the case of a medium which will permit of half-a-dozen vibrations before the wave is quenched, a very thin film will suffice to stop light waves which are of the order of a hundred-thousandth of an inch in length, while a much thicker stratum would be required to stop the Hertzian waves which may be from a foot to some few yards in length, while no practicable thickness would stop the waves from an alternating dynamo, say with a periodicity of 100 vibrations a second, as in this case the wave length would be something like a couple of thousand miles.

Unfortunately, as the wave length increases, the second condition is less and less perfectly fulfilled.

The reason for this is extremely interesting. Sir George Gabriel Stokes, so long ago as 1849, showed by mathematical reasoning from observed optical phenomena, that when a wave of light is excited from a given source, the radiation is emitted, not from the source itself, but from a point a quarter wave length in advance of it. This very curious phenomenon is completely explained when light waves are admitted to be of electromagnetic origin.

When an electric disturbance is set up at a certain point, it is always accompanied by a magnetic disturbance in a plane at right angles to it. The electric disturbance occurs a quarter of a period later than the magnetic, but it starts a quarter of a wave length in advance, so that, except within the first quarter wave length, the two travel together, their zero and maximum values always occurring at the same points.

Within the first quarter wave length, however, the two disturbances sometimes reinforce and sometimes oppose each other, and the result of this, as Professor Poynting has shown, is that, within the first quarter wave length, the energy originally proceeding from the source of the disturbance is sometimes travelling forward and sometimes backward towards the source, so that, although more goes forward than comes backward, a large proportion is wasted.

Beyond the first quarter wave length, however, the two disturbances tend always to cause an outward flow of energy.

It is, therefore, easily seen that in the case of a wave a hundred-thousandth of an inch in length, the point from which the radiation begins being only the four-hundred-thousandth of an inch from the source, there will be very little energy returning to the source.

On the other hand, in the case of a dynamo such as referred to above, with a wave length of some 2,000 miles, the emission point would be some 500 miles

from the source, so that very little of the energy of the source would reach this point, by far the larger proportion being returned to the source.

We see, then, that the two conditions to be fulfilled are diametrically opposed to each other, and it becomes a matter for experimental investigation to determine what kind of wave lengths are most advantageous for telegraph work under varying conditions as to distance and other circumstances.

The preceding brief outline of the principles underlying the Hertz wave method of wireless telegraphy, will enable the reader to follow the descriptions of experimental work and practical details with greater facility, and, I trust, also with greater interest, by reason of his having obtained a general view of the fascinating country through which I am to have the privilege of acting as his guide.

Before proceeding to this exploration, however, I will ask him to linger with me for a moment to take a passing glance at two other methods, which are as yet in the infantile stage, but one or both of which may not impossibly in time outgrow their elder brother.

These are, the system of conduction through the sea or moist earth, and the system of electromagnetic induction.

In the earliest attempts at electric telegraphy, a complete metallic circuit was employed, requiring a pair of wires to connect any two stations.

In the year 1838, Steinheil tried unsuccessfully to utilise the two lines of rails of a railway in place of overhead telegraph wires, but, as has so often happened, his investigations into the cause of his failure led him to a most important discovery.

He found the reason to be that the earth was so good a conductor, that the electric current from the transmitting station, instead of flowing along one of the rails to the distant station and returning by the other, as he had anticipated, simply flowed across to the other rail through the earth on which they rested, and this at once suggested to him that it should only be necessary to have one wire between the two stations, provided this wire was earth-connected at each station, and this he found to be the case.

He also suggested that, the earth being so good a conductor, it might be possible to do away with connecting wires altogether, but I am not aware of his having devised any means by which this could be done.

Four years later the American, Professor Morse, who took so large a share in the development of electric telegraphy, succeeded in transmitting messages across a canal, 80 feet in width, and afterwards across the Susquehanna River, a distance of nearly a mile, by the

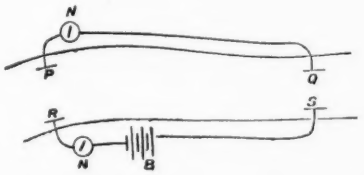

FIG. 1.—Morse's method of transmitting messages across the Susquehanna River.

method shown in Fig. 1, where B is a battery, N N a pair of needle instruments for transmitting and receiving signals, and P Q R S are metallic plates immersed being connected with insulated wire.

He obtained very good results when the distances from P to Q and R to S were three times as great as those from P to R and from Q to S.

In this connection I cannot refrain from pausing for a moment to refer to J. B. Lindsay, of Dundee, a Scotch schoolmaster of the very slenderest means, who made several important electrical discoveries, though unfortunately very little was heard of them except by his immediate neighbours, until they were unearthed some few years ago, when they were only of historical interest. He carried out a long series of experiments similar to those of Morse, quite independently but a year later.

After this, the subject appears to have excited very little attention, until in the year 1880, Professor John Trowbridge, of Harvard College, discovered that all the neighbouring telephone circuits were affected by the time signals sent from Harvard to Boston, some four miles away. He investigated the cause of these disturbances, and found that they were not due to induction, but to earth currents produced by leakage from the clock circuit.

Trowbridge saw at once that this might be utilised for the purpose of sending telegraphic messages without connecting wires, and he proposed attempting to telegraph across the Atlantic by sending alternating currents from a large dynamo through an insulated cable extending from Nova Scotia to Florida and earthed at each end, and placing another long wire with a telephone in its circuit down the coast of France.

He proposed signalling to ships at sea by means of similar means, and also by means of magnetic induction between coils carrying interrupted currents and using a telephone as detector, but he found that it would be necessary to employ either coils, far too large for use on board ship, or extremely heavy currents.

During the following year Graham Bell, the inventor of the telephone, began some interesting experiments of which I will only describe one, which he carried out on the Potomac River.

A battery and an interruptor were placed in a boat and connected by a wire about 100 feet long, one end of which was soldered to a metallic plate immersed in the water near the bow, while the other end was attached to a similar plate, which was buoyed by a float and allowed to trail astern. Bell himself was in another boat similarly equipped, except that the battery and interruptor were replaced by a telephone, and he found that he could clearly distinguish the signals at a distance of a mile and a quarter from the first boat. He strongly urged that a similar method should be employed for communicating between steamships, the steamer's electric lighting dynamo being used to replace the battery.

In 1882, Mr. W. H. Preece, now Sir William Preece, began to turn his attention to the subject with a view to effecting communication with lighthouses and lightships, where continual interruptions occur owing to the cables being broken or damaged by the heavy seas.

One of his earlier experiments was to establish a telegraphic circuit between Southampton and Newport in the Isle of Wight.

As shown in Fig. 2, one wire was carried from Portsmouth through Southampton to Hurst Castle, the two ends being connected to large metallic plates immersed in the sea at Southsea Pier and Hurst Castle respectively. Another overhead wire was carried from

Ryde through Newport to Sconce Point, and the ends connected as before to metallic plates immersed in the sea.

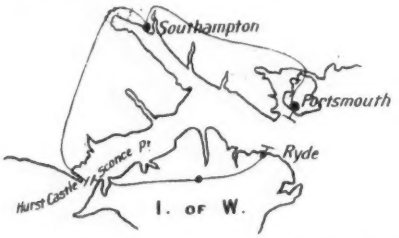

FIG. 2.—Preece's method of transmission between Southampton and Newport.

With 30 Leclanche cells and a buzzer and Morse key at Southampton, the signals were found to be perfectly audible at Newport in a telephone on the circuit.

Three years later Mr. Preece arranged some interesting experiments on wireless telegraphy by electromagnetic induction in the neighbourhood of Newcastle, which were carried out by Mr. A. W. Heaviside. Two squares of wire, each side a quarter of a mile in length, were placed at distances a quarter of a mile to 1,000 yards apart. In the former case the signals could be easily read by a telephone in the receiving circuit, and audible sounds were produced even at the greater distance.

Further experiments were made with parallel lines of telegraph, ten and a quarter miles apart, between Durham and Darlington, and it was found that the ordinary working currents in one line produced distinctly audible sounds in a telephone in the other. Equally successful experiments were made between parallel lines of telegraph on the East and West Coasts about forty miles apart, but in these experiments there arose the question whether the effects might not be due in part to leakage from the network of telegraph wires covering the intervening country.

The first practical application of the results of these experiments was to establish communication between Lavernock Point near Cardiff and two islands, Flat Holm at a distance of about three and a third miles, and Steep Holm at a distance of rather more than five and a third miles. (See Fig. 3.)

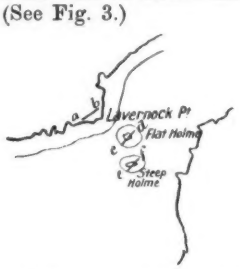

FIG. 3.—Preece's method of transmission between Lavernock Point and the Islands Steep Holme and Flat Holme.

On the shore a copper wire 1,267 yards in length was suspended on poles and earthed at each end. In this circuit was an alternating dynamo capable of giving a current up to 15 amperes, and a Morse key for breaking up the alternations into signals. At a distance of 600 yards from this circuit, on the sand at low water mark, a secondary circuit, composed of two gutta percha covered and one bare copper wires, were laid down and their ends buried in the ground. On the two islands, gutta percha covered wires, each 600 yards long, and parallel to those on shore, were laid down. The signals in the telephone on Steep Holm were audible, but not sufficiently distinct to be read, but messages were easily read off in the telephone on Flat Holm.

I will conclude this article by a brief reference to a method devised and patented by Mr. Willoughby Smith, and a modification patented by him in conjunction with Mr. W. P. Granville.

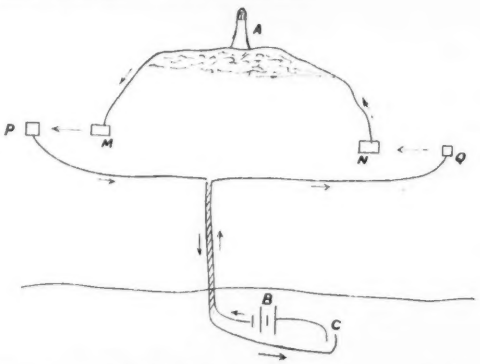

FIG. 4.—Willoughby Smith's method of communication between a lighthouse and the shore.

In Fig. 4 a lighthouse is shown at A, and insulated wires lead from the terminals of a telephone in the lighthouse to metallic plates, M N, submerged on opposite sides of the rock. Two other plates, P and Q, submerged to a sufficient depth to be unaffected by waves, are connected by an insulated cable, having in circuit with it a battery, B, and an interruptor, C. The course of the current is shown by the arrows. The modification of Mr. Willoughby Smith's method is shown in Fig. 5, which illustrates its application to communication between the Fastnet Rock, off the S.W. coast of Ireland,

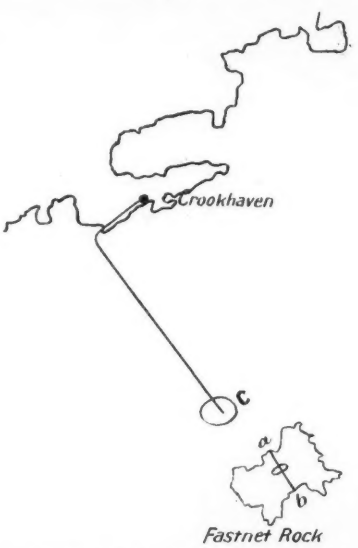

FIG. 5.—Method of Willoughby Smith and Granville employed in communicating between Crookhaven and the Fastnet Rock.

and the town of Crookhaven, eight miles away. An insulated cable from the shore is earthed at the shore end, and also by means of a heavy copper anchor, C,

near the rock. A conductor, a b, containing a receiving instrument, which in this case is a d'Arsonval galvanometer, is earthed at a and b on opposite sides of the rock by connection with submerged masses of copper, and whenever a current flows through one circuit there will be a difference of potential produced at the ends of the other circuit, resulting in a flow of current which is shown by the galvanometer.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor ALFRED C. HADDON, M.A., D.SC., F.R.S.

IN the following series of articles I propose dealing with various human social groups in different stages of culture. History is not concerned—or should not be—merely with the rise, progress, and downfall of dynasties and with the doings of great men; but it takes into cognisance the evolution of the people in general. The population of any country is not an incoherent mass, but is composed of groups, and it is the business of Sociology to study the origin and history of these groups, which are subsequently welded into nations. Sociology is partly the study of the raw material of History as it endeavours to account for the idiosyncrasies of societies and groups of men whose ultimate fate is described by History. It may perhaps not inappropriately be termed the Natural History of History.

I claim no originality in the method of treatment. Several years ago I had the good fortune to assist Prof. Patrick Geddes in his stimulating Summer Courses in Edinburgh, and it was there that this method of study was brought under my notice.

My friend M. E. Demolins, editor of "La Science Sociale," has given me permission to utilise the series of sociological studies that have appeared in that highly original journal. As the system initiated by Le Play and so ably elaborated by MM. E. Demolins, R. Pinot, P. de Rousiers, Henri de Tourville, and others is but little known in this country—I have ventured to introduce it to the pages of KNOWLEDGE. There is not space here to expound the system, which after all may be best illustrated by the treatment of the several articles.

The first article is mainly an abbreviated translation of papers by M. Demolins in the first volume of "La Science Sociale," but I have not hesitated to give fresh examples and to add qualifications to many of his propositions.

I.—THE HUNTERS.

ENVIRONMENT.—As Europe is so largely deforested and cultured one must go elsewhere to study the hunter type in its purity. Indeed at the present day it is not easy to find people who are pure hunters. The Australians do not cultivate the soil, but their conditions of life are somewhat peculiar, and it will be better to consider the hunting folk who dwell in tropical forests where the environment is fairly uniform.

The greatest forest region is that of the valleys of the Amazon, Orinoco, and of the rivers of the Guianas, an area about equal to that of Europe.

The physical features, climatic, meteorological and geographical, which deserve a more extended consideration than can here be given to them, determine the nature of the vegetable products, which in this case constitute an immense forest. The prolonged humidity permits the growth of trees, and these by cutting off light and air stifle the growth of grass. Vegetation is rampant, savage man is powerless against it. As Bates says, "In the equatorial forests the aspect is the same, or nearly so, every day in the year; budding, flowering, fruiting, and leaf-shedding, are always going on in one species or other. It is never either spring, summer, or autumn, but each day is a combination of all three."

OCCUPATION.—The climatic conditions and the luxuriance of the forest render agriculture very laborious, especially in the low-lying lands; the line of least resistance is found in living by hunting. There is something to be said in favour of this mode of life.

The attractions of hunting are very great. In all grades of even the most artificial or civilised societies there are people who have an almost irresistible impulse to hunt; the instinct of the poacher is similar to that of the aristocratic sportsman who slaughters half-tame pheasants or who stalks deer, or to that of the hunter who travels afar in search of big game. This fascination is evidently felt by those who are practically compelled by circumstances to become and remain hunters.

Hunting requires no foresight. An intimate knowledge of the habits of animals is necessary for existence, but no forethought is required to maintain the supply. The breeding of animals for food or industrial requirements belongs to a later stage of culture, the sole exception being the domestication of the dog, which has been more or less thoroughly accomplished by most hunting peoples.

The capture of each day provides the food of each day, and this must be consumed immediately for it cannot be preserved. Various methods have been devised for drying or smoking meat, but even so it cannot be kept for long periods like tubers or cereals.

Hunting is suited to the generality of men, for it is interesting, and it calls forth intelligence and the satisfaction of outwitting animals; it gratifies the lust of killing, and supplies an exciting element of chance, which keeps hope alive through disappointments. The food is stimulating and enjoyable. No preparatory work or thought is required to provide the supply of food. These conditions appeal to the majority of mankind.

Although there are no great possibilities in this mode of life, the chase provides for the diverse wants of man. The meat serves for food. The Eskimo prove that it is possible to live exclusively upon a meat diet; in warmer climates there are numerous edible roots, shoots, leaves and fruits which can be had in the various seasons for the picking. The skins provide clothing, materials, for habitations, vessels and the like. It is only in temperate and cold climates that clothes are necessary for warmth, and decency requires but a minimum of clothing which in tropical countries is provided by bark or leaves. The same practically applies to habitations. It is mainly the hunters of the prairies, or the inhabitants of other treeless districts like the frozen lands, who make use of skin tents. Under the same conditions various portions of the animals are employed for different purposes which the vegetable world supplies in the tropics with the expenditure of less labour to men—such, for example, as fibres and receptacles like gourds. The feathers of birds furnish finery all over the world, but perhaps nowhere have they been employed to the extent that they are, and were, in tropical South America. The hunters there can live isolated from more complicated societies as they are self-contained, and thus they retain a simpler, and probably more primitive, social condition.

XUM

The pursuit and capture of prey require special qualities: agility, dexterity, and strength, in addition to woodcraft. These aptitudes are most particularly found among the young men, hence there arises a tendency for superiority of youth over age, unless social institutions are evolved to counteract it, as, for example, occurs in Australia. In any case the youths are early able to provide for themselves, and in consequence they set up an establishment as soon as possible. In extreme cases they retain to themselves the fruit of their labours, and repudiate the duty of assisting their aged parents. As will be stated shortly, the means for subsistence are strictly limited, and the first biologic law—that of self-preservation—is imperative, come what may.

It is one of the first duties of social organization to modify this crude state of affairs, and to prevent the children from arrogating to themselves an undue amount of authority. The arrogance of youth is a natural outcome of the feebleness of parental control.

The development of primary individualism is the result of this mode of life. This form of individualism is of the lowest, that is, of the least social, character.

It is usually to the hunter's interest to isolate himself and to hunt his prey on his own account. Some people temporarily combine to drive their quarry into nets or traps, but hunting is chiefly done single handed.

The tendency to individualism is still further developed by the facilities which hunting offers to the establishment of new and distinct households; a very different state of affairs to the value of aggregated families in sedentary communities. The dwellings of hunters are simple huts, made of branches and covered with leaves or made of skins. They are easily erected, and in the latter case are easily portable; but in warm climates a rain-proof hut can be made in a very short space of time with the materials that are ready to hand. It costs no money to make and but very little time, and no regret is felt at leaving it.

The household furniture is of the most rudimentary character, on account of the migrations necessitated by the chase. It is provided by the wood of the forest, by gourds, shells of nuts, carapaces of turtles, shells of molluscs, in fact of anything ready to hand that will serve.

The implements for the chase are quite as elementary, wooden spears, bows and arrows for terrestrial animals; a canoe and fish-spear, or a line and hook, for fishing. A few hours' work would suffice to make them all. In the district of the Orinoco there are two kinds of canoes. (1) A sufficiently large tree is chosen from which a piece of bark several yards in length is detached. This is folded and its ends strongly secured by lianas. Later the canoe is covered with leaves and placed over a great fire. This operation not only hardens it but makes it start and it only remains to caulk the cracks with a kind of gum supplied by neighbouring trees. (2) The other canoes are tree-trunks hollowed out by hatchets; although this operation is longer it is accomplished pretty quickly. Crevaux states that it takes four men only four hours to make a bark canoe. On several occasions, when stopped by a rapid, they did not hesitate to abandon one and to make another in order to continue their voyage on the other side of the fall.

There is, however, a very marked limitation of the means of existence. Game and fresh-water fish are more easily exterminated than the grass of the prairie and the fish of the sea. In our complicated societies it is necessary to frame special laws to regulate fresh-water fishing, and even the inshore marine fishing grounds are liable to depletion, and certain methods of marine fishing have to be prohibited or limited by law.

The existence of hunters is not so assured as that of pastoral or fishing communities. The game may be over-hunted or become scarce through disease or unfavourable seasons, hence hunting populations are subject to cruel famines. They cannot reserve food for these periods of famine in tropical countries, as the temperature necessitates the immediate consumption of the product of the chase. At most they can preserve meat for four or five days by submitting it to the action of a strong fire.

The question of food is the principal occupation of savages. "Our voyage," said Crevaux, "resolved itself into a regular struggle for existence. All the time we could spare from our survey and our observations was devoted to fishing and hunting."

The uncertainty of the means of existence gives to the savages a particularly accommodating stomach. They can remain several days without eating, and when food is abundant they can gorge a prodigious quantity.

The chase obliges the savage to periodically migrate. He must follow the game, or the migration of fish, or visit the banks at the turtle-egg season. Following the annual migration of the bisons across the prairies was not difficult to the North American Indians, but it is a different matter in tropical forests, owing to the tangled luxuriance of the vegetation and the general absence of paths. Hence they walk in "Indian file." So inveterate is this habit that they walk in single file when there is no occasion to do so.

The difficulty of communication is so great that there are scarcely any relations between different tribes, and from this arise a multiplicity of dialects.

The whole family has to follow the periodical migrations, and there is consequently a high mortality for the aged, sick, and even children; that is, those who cannot easily transport themselves are frequently abandoned.

It will be asked, Why do not the hunters seek in cultivation of the soil a more abundant and assured means of existence? It is probable that this has often taken place, but there are hunting communities that do not till the soil. In the district which we have more particularly under view, when game is abundant for several years, certain tribes multiply to the extreme limits of the local resources. They then manifest a tendency to agriculture; but this mode of life necessitates more effort and offers less attractions than the chase, and is especially repudiated by the young. The paternal authority which should exercise a sufficient constraint upon the latter is very feeble.

The attempts at cultivation are not persisted in and are soon abandoned; as Le Play has pointed out, "The frequent atmospheric calamities in this region of the equatorial zone happen to justify the repugnance of the population to works of agriculture. Epidemics have not only the result of reducing the tribes of the aged and the more feeble, they destroy entire tribes, and thus re-establish the equilibrium between the mouths and the means of sustenance." Such are some of the causes which oppose the transformation of hunters into tillers of the soil.

There are in the forests of the New World some very rudimentary plantations of rice, yams, sweet potatoes, sugar cane, manioc, etc. The manioc produces tapioca and a fermented drink; four days' work per month in their plantations provide sufficient food for a family of

nine persons. Yet the hunters only do this to satisfy their most urgent requirements.

Despite uncertainties and cruel disappointments, the chase holds and retains the savages, and if occasionally necessity compels them to take one step towards tillage they do not persist in this effort, and return with eagerness to the more attractive work of hunting.

PROPERTY.—The forest theoretically belongs to everybody because its products are not the result of any work by man. The extent of commonage accessible to each family is much more restricted than the steppes or the sea. This limitation arises partly from the difficulties of locomotion, which confine the hunters to a relatively limited district; partly from the nature of the spontaneous productions. As these are easily exhausted the several families are obliged to energetically defend their hunting grounds against the inroads of neighbours.

If the hunting grounds are under the rule of the community this is not the case with the home and implements of work. These are personal property on account of the division into isolated households. But we have seen how restricted they are and how easy to make. This property, therefore, contributes in only a very feeble manner to develop habits of forethought and economy.

Thus the hunting savage is naturally improvident. His true property consists in his skill and agility, which he can neither sell nor bequeath. The grave question of the transmission of property does not exist for him. No tie binds, even materially, the generations with one another to induce solidarity. Individualism triumphs.

THE FAMILY.—The family cannot retain its members at home, all the children successively separate as soon as they can provide for themselves. The family periodically dissolves, scattering to found new homes as instable as the preceding. Such are the characteristic traits of the instable family, which develop the spirit of change.

The spirit of change is manifested by the preponderance acquired by the young, unless, as previously stated, special precautions are taken to prevent it. The youths, by reason of their premature emancipation and comparative isolation are not permeated by the traditions of their ancestors or the sentiments, ideas, and habits of their parents, except so far as they maintain that conservative spirit which is so characteristic of children and backward peoples.

The chief of these small families forget the memory of their elders, and take no pains to transmit the remembrance of the great actions of the race to their descendants. Verbal history, so prolix in sedentary communities, is almost non-existent among nomadic hunters.

Magical practices may be developed, but true religion —that is, the worship of a spirit or spirits—is in a very primitive stage.

Among the South American hunters not only is there no respect for their progenitors, but they may abandon and even eat their parents. The instable family often leaves orphans, the sick, the aged—in other words, the feeble and incapable—without refuge and sustenance; there is no fixed home to act as a place of refuge.

GOVERNMENT.—It is necessary to be young, vigorous, enterprising, if the home, children, and hunting grounds are to be protected from the incessant attacks of neighbouring tribes. Power belongs to the strongest, and is thus not only despotic but cruel.

Each tribe must be organised for defence, and for attack—it must always be on the alert. It is to the interest of the families to group themselves under a valiant chief capable of protecting them and their possessions. Thus, this state of permanent war develops a kind of personal authority; the habits of the chase render it arbitrary and cruel; the feebleness and instability of the family permit to encroach, but the authority is itself instable. Force makes chiefs, force unmakes them.

Primitive Gaul, as Le Play points out, was in a similar condition; "obliged to struggle without ceasing in order to procure their living, and to defend the game agaist the inroads of contiguous peoples, the early Gauls approached in their habits the Indian hunters whom one may still observe in the forests of America." On their arrival the Romans found the Gauls divided into a multitude of small tribes constantly at war. The policy of Cæsar consisted in setting one against another. It was the internal weakness of the Gauls that made them powerless against the Romans.

INCAPACITY OF THE HUNTERS TO EXPAND.—First, there is an absence of the means of transport, being without the horse or a seaworthy boat, for bark canoes and simple dug-outs are quite unsuited for maritime navigation.

Secondly, owing to the isolation of the families there is very little communication between them, and there is a marked lack of co-ordination. Relatively small bodies of men may temporarily combine, but large enterprises are practically impossible, not only from the lack of social education, but from the difficulty of obtaining sufficient food.

Finally, the population is limited. The population is diminished by epidemics, the abandonment and death of those whom they cannot transport, intertribal wars, and cannibalism. Hunting peoples always multiply very slowly, and they even tend to disappear. The Indians of the Amazon diminish rapidly in contact with the white man, and so also do the North American Indians and the Australians. The Tasmanians have entirely disappeared.

POLARITY IN MAGIC SQUARES.—I.

By E. D. LITTLE.

PYTHAGORAS found the secret of the Universe in Number and Duality or Polarity, for Number is Law, and Law divides all things into complementary pairs.

The universal reign of law, the essential unity of law, and yet the diversity of its operation, the Duality or Polarity of its subject matter, all these receive abundant illustration from the number-problem known as the Magic Square, which has always had a singular fascination for the Mystic and the Mathematician alike.

The object of this paper is to show how well the least and simplest of these figures will serve for the purpose of this illustration, for although De minimis Lex non curat may be Lawyer's Law, it is not the Law of Nature. In Nature Law reigns as supreme in the least as in the greatest, and it is in the least that it is often best observed.

In treating of a subject at all scientific in character it is always well to begin with definition, and our first care must be to define the nature or the note of the Magic Square. A Magic Square then is a square of

numbers so arranged that the numbers in each of its rows, columns, and diagonals, amount to the same sum, as in Fig. 1, where the numbers 1 2 3 4 5 6 7 8 9 are

6	1	8
7	5	3
2	9	4

Fig 1.

1	2	3
4	5	6
7	8	9

Fig. 2.

so arranged in the form of a square that the rows 6—1—8, 7—5—3, 2—9—4, the columns 6—7—2, 1—5—9, 8—3—4, and the diagonals 6—5—4, 8—5—2, all amount to 15.

This definition calls for some comment. In the first place it presupposes a square, apart from the numbers, in which a certain construction has been made, a geometrical square which has been divided by lines parallel to its sides into a number of equal rows, and the same number of equal columns, of small squares, or positions, as they will be called.

Furthermore the definition involves a classification of the parts into which the whole figure is divided, as (1) rows of positions, (2) columns of positions, (3) diagonal lines of positions. A moment's consideration shows that this classification is incomplete. The word diagonal is not of the same extension as the words row and column.

The rows comprise all the positions of the Square, taken three at a time; so do the columns; but not so the diagonals, which in one direction comprise three positions, and in another direction three also, one of which is common to both diagonals. The classification is therefore not exhaustive. It may be made so however by extending the meaning of the word diagonal so as to include parallel to a diagonal. For with this extension the diagonals will comprise all the positions of the square, taken three at a time, in two oblique directions, related to one another in precisely the same way as the rows and columns are related. Let the positions of the square Fig. 2, be numbered in the usual or natural order.

We may then arrange the positions in four classes, according to their direction.

(1) 3 rows of 3 positions each,	1—2—3, 4—5—6, 7—8—9
(2) 3 columns of 3 positions each,	1—4—7, 2—5—8, 3—6—9
(3) 3 diagonals of 3 positions each, descending to the right,	1—5—9, 2—6—7, 3—4—8
(4) 3 diagonals of 3 positions each, descending to the left,	1—6—8, 2—4—9, 3—5—7

If we wish to distinguish (3) and (4) we may call (3) positive diagonals or + diagonals, and (4) negative diagonals or — diagonals.

We may also distinguish the diagonals in the usual sense from the diagonals in the extended sense by calling the former the middle diagonals. And we may class together the rows and columns on the one hand, and the two kinds of diagonals on the other, as laterals (for they are measured by the sides of the square), and diagonals.

We shall now be prepared for an analysis of the magic square of 3, and for a comparison of the magic square with the complement which by the universal law of things must somewhere exist. The square which stands in this relation of polarity to the magic square is shown in Fig. 3, and is called the Natural Square, and the object now in view is to establish and illustrate the completeness of the polarity existing between these two squares.

The law might be called in general terms the law of polarity in direction, but, as might be expected, it shows itself under various aspects, which will have to be considered separately.

I. SUMMATION.—Equal summation of all rows and columns is the special note of the magic square; for in the equal summation of its mean diagonals and mean laterals it is undistinguishable from the natural square.

Now if the square in Fig. 1 be compared with that in Fig. 2 it will be seen that the + diagonals of the first are the columns of the second, and its — diagonals the rows.

The diagonals therefore of the Natural Square, and the laterals of the Magic Square have equal summation, and polarity of direction as regards summation exists between the two.

II. DIFFERENCE.—Let the series 1 2 3 4 5 6 7 8 9 be regarded as a recurring series, that is to say a series in which we may begin at any point, read in either direction to either end, revert to the other end, and read in the same direction to the starting point as 4 5 6 7 8 9 1 2 3 or 5 4 3 2 1 9 8 7 6. In all these readings of the series the difference is said to be 1, for successive terms are taken at intervals of one position. Now let the series be varied by taking successive terms at intervals of 2, 3 and 4 positions respectively; it will be unnecessary to go further since by so doing we shall only obtain the same variations inverted.

The possible variations for these differences will be found to be—for

	or			
1,	8.	1 2 3	4 5 6	7 8 9
2,	7.	1	3 5 7	9 2 4 | 6 8 1
3,	6.	1 4 7	2 5 8	3 6 9
4,	5.	1 5 9	4 8 3	7 2 6

When the difference is 3 or 6, it is impossible to complete the series without beginning at three different starting points since the third position after 4 is 7, the third after 7 is again 1.

Now if these variations of the series be divided each into three triads, beginning with 1 in all cases except where the difference is 2 or 7, when a triad must begin with a multiple of 3, the triads will be found to be identical with the lines of the Natural and Magic squares, and the distinction between the squares to lie in the direction of the differences.

The subjoined table shows the directions of the differences in each square:—

Natural.	Differences.	Magic.
Rows	1 or 8	—Diagonals
Columns	3 or 6	+Diagonals
+Diagonals	4 or 5	Columns
—Diagonals	2 or 3	Rows

Thus polarity of direction as regards differences exists between the two squares.

III. ODD AND EVEN CROSS.—If the Natural and magic squares be compared as regards the position of odd and even numbers, it will be observed:

That odd and even numbers are alternate in the outside rows and columns and either in the middle laterals or middle diagonals of each.

That in the Natural Square the odd numbers all lie in a diagonal cross, the even in a lateral cross.

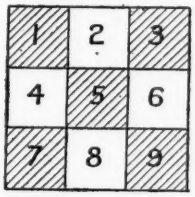

Fig. 3.

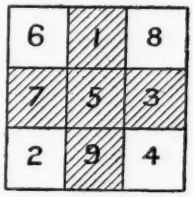

Fig 4.

That in the Magic Square the even numbers all lie in a diagonal cross, the odd in a lateral cross.

In this respect therefore there is complete polarity of direction between the two squares.

(*To be continued.*)

THE FLY, "SYRITTA PIPIENS."

By WALTER WESCHE.

A CAREFUL study of the anatomy of insects, aided by the higher powers of the microscope, though a pursuit of great interest, taxes the observer's ingenuity to account for the changed aspect of organs when rendered transparent, flattened, and mounted under pressure. The appearances presented are often likely to lead to erroneous conclusions, unless one is acquainted with the position and shape of the object in its natural condition. A knowledge of the life-history and habits of an insect is also essential if a correct idea as to the uses and purposes of the several parts are to be arrived at. For instance, there is a beautiful contrivance on the tibia of the forelegs of most of the Hymenoptera, and some of the Coleoptera, for cleaning the antennæ, which, had not Mr. Frank Cheshire observed its use, would probably be still regarded as an auditory organ. The great elaboration and specialization of different mechanisms for various purposes displayed in the anatomy of insects are only equalled by the economy of means; every part is, or has been, in some way, of use to its possessor, though what that use is is often a difficult matter to divine.

Syritta pipiens, with its complicated lancets (fig. 3); the process of knife-like setæ on the tibia of the fore leg (fig. 6), which is usually found in predaceous flies

FIG. 1.—*Syritta pipiens.* Female. Femur of hind leg flattened.

and beetles, and used in holding prey; the many chitinous setæ on the tarsi of the middle leg, disposed in fairly regular patterns (fig. 5); and the remarkable hind leg (fig. 4), which at first view seems adapted to the curbing of the struggling wing of a powerful opponent, might incline to the opinion that the fly was raptorial, and used these parts in pursuit and capture of its prey. The insect is very well known and common from April to October. It belongs to the family Syrphidæ, or "Hover flies," and feeds on the pollen of flowers, of which its abdomen may often be found full.

FIG. 2.—*S. pipiens.* Male.

It is figured and described under the name of Musca pipiens in the work of the old French entomologist, De Geer, and so exhaustively that most later writers quote his observations (Westwood and others). It was named from its habit of uttering an exceedingly acute cry when held, the sound being produced through the two large pear-shaped spiracles on the thorax. De Geer found the larvæ in the dung of horses and cows; it is thicker in front than behind, and has a small point on the head.

The male (fig. 2) is a little smaller than the female,

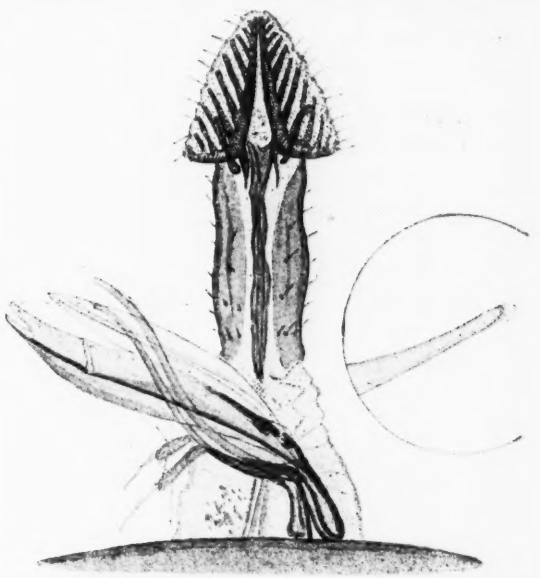

FIG. 3.—Mouth organs of *S. pipiens*, proboscis, lancets, and maxillary palpi; smaller circle has tip of lancet more magnified and showing hairs. × 46 diameters.

as is usually the case in insects, and the mouth organs and legs do not differ, with the exception that the male carries a series of very short chitinous spines on the coxæ of the hind leg—"a secondary sexual" characteristic, enabling him to hold the female in a firm grip (fig. 4). The same process is to be found on the males of Erystalis (bee or drone fly). The coxæ of the female are quite plain, and both sexes have a pretty and delicate fringe of hair on the abdomen to protect the femur of the hind leg from the effects of chafing. The male, in its markings, also differs from the female, these external characteristics being larger and lighter on the dorsal region of the abdomen, and there is a smaller space between the eyes (facies).

This fly may be seen on a sunny day hovering over flowers, or busy with the pollen, and is described as having a "characteristic quiet manner of moving on a plant."

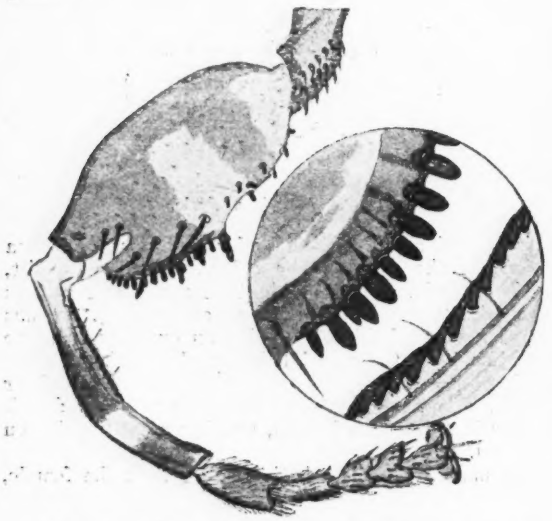

FIG. 4.—Hind leg of *S. pipiens*; the smaller circle shows the processes on the edge of the femur and tibia more magnified. × 22 diameters.

It will be seen on examination of the mouth organs (fig. 3) that there are no pseudo trachæ on the labella of the proboscis, and no teeth; also on looking at the smaller lancets with a power of three hundred and fifty diameters, that they are not piercing organs, but bear a very delicate series of fine hairs on the tip (small circle on fig. 3).

The hind leg (fig. 4) is truly remarkable; the process of blunt knobs or teeth on the femur, and of bent

FIG. 5.—End of tibia, and part of tarsi of middle leg, of *S. pipiens*. × 94 diameters.

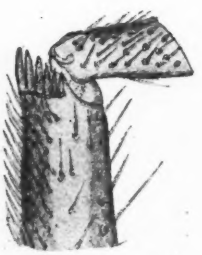

FIG. 6.—End of tibia of fore leg of *S. pipiens*. × 125 diameters.

spines on the tibia, are contrived to lock on to each other and so constitute a sort of pincer. From its extraordinary elaboration and powerful construction it must play an important part in the insect's life-history; it is probably used in crushing some kind of capsule or part of a flower to admit of the pollen being extracted. By careful focussing with a power of three hundred and fifty diameters, some minute trachæ may be detected above the knobs on the femur (small circle, fig. 4.)

It is possible that the spines on the tibia may be capable of erection, as there appears to be some trace of a muscle underneath them. Of the uses of the setæ on the middle and fore legs it is difficult to form an idea; they may be the remnant of former useful appendages, the insect having changed its manner of obtaining food, but from their very marked character and the modification which in that case has taken place in the lancets, leaving them unmodified, this is very improbable; besides, the spines at the end of the tibia of the fore leg are found in most, if not all, of the Syrphidæ.*

An antenna is shown in fig. 7. It resembles Syrphus balteatus and others of the family; the small circular markings are probably olfactory organs, and would be of service to a flower-feeding insect; at a deeper focus there is a curious organ of a rather vermiform appearance, which seems to be for the same purpose. The male organs are very interesting, and can seldom be so well seen as in this fly—though even here it is far from easy to make a satisfactory diagram (fig. 8); two large feeling organs, two "claspers" (fig. 9), and two inner "holding organs" (fig. 10), as well as a seminal duct, are all clearly seen, but other parts are very nebulous,

FIG. 7.—Antenna of *S. pipiens*. × 50 diameters.

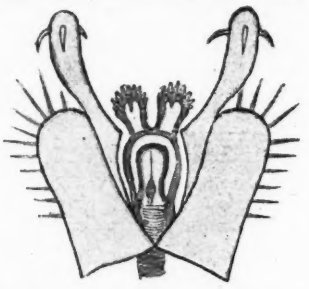

FIG. 8.—Diagram of the hypopygium of *S. pipiens*.

overlap, and difficult to differentiate. The apparatus shown in fig. 10 is a very pretty microscopic object, and with the "claspers" (fig. 9) (note how the setæ are turned back so as to form hooks) and the process on the coxæ of the hind leg, are obviously all modified with the object of accentuating the male's firm hold of the female. The remarkable elaboration and complexity of detail on this minute fly (the female is $\frac{3}{8}$ of an inch long, the male a little less), cannot fail to strike an observer. It is interesting to compare this insect with another nearly related to it. Ascia podgrica is rather smaller, and the abdomen very different in shape, being a pointed oval tapering with a curve to the base, but the wings, the fore legs, and the mouth organs are identical; the femur of the hind legs is thickened in precisely the same manner, but it is toothed with sharp setæ, and there are no spines on the tibia, the edge being hardened and chitinous instead; the middle legs lack the elaborate spines, and the antennæ are slightly different in shape. Erystalis pertinax and Heliophilus trivittatus carry a

* I have had an opportunity of watching, at all events, one of the uses of the hind leg; a female extended her long membranous ovipositor and drew it very carefully through the teeth of the femur and tibia, which were compressed for the purpose; this was repeated many times. I am inclined to think that the numerous hairs and spines on the legs are primarily intended for cleaning purposes.

XUM

NEBULA H IV. 41 SAGITTARII.

By ISAAC ROBERTS, D.Sc., F.R.S.

XUM

similar apparatus on the hind leg, but the femur is not nearly so thickened; it is armed with sharper spines than S. pipiens, and the tibia is furnished with a similar

FIG. 9.—"Clasper" of male *S. pipiens.* × 100 diameters.

FIG. 10.—"Holding organ" of male *S. pipiens.* × 275 diameters.

process, though not quite so continuous. The explanation of these variations forms an interesting problem, which with opportunity for observation, I do not think is incapable of elucidation.

In conclusion it is my duty and my pleasure to express my obligations to Mr. E. Austen, of the British Museum, for information on the life-history, literature, and the kind gift of specimens of S. pipiens.

PHOTOGRAPH OF THE TRIFID NEBULA H IV. 41 SAGITTARII, AND OF THE REGION SURROUNDING.

By ISAAC ROBERTS, D.SC., F.R.S.

THE photograph annexed is of the region in the sky comprised between R.A. 17h. 54m. 12·8s. and R.A. 17h. 58m. 42·1s., and in declination between south 23° 37′·6 and 22° 16′·6. The area, therefore, is 4m. 29·3s. in extent from *following* to *preceding*, and 1° 21′ from north to south. Scale—one millimètre to twenty seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900.

Star (.) D.M. Schönfeld No. 4503 Zone – 22° R.A. 17h. 55m. 50·8s. Dec. S. 22° 46′·1. Mag. 6·0.
Star (..) D.M. No. 4533 Zone – 22° R.A. 17h. 57m. 53·6s. Dec. S. 22° 50′·7. Mag. 7·4.

The *Trifid* nebula H IV. 41 is in R.A. 17h. 56m.; declination, south 23° 2′.

REFERENCES.

N.G.C. No. 6514. G.C. 4355. *h* 1991=3718. *Phil. Trans.*, 1833, Pl. XVI., Fig. 80. *Cape Obs.*, Pl. II., Fig. 2.

The photograph was taken with the 20-inch reflector, and exposure of the plate during 90 minutes, on the 13th July, 1899; and it will be observed that the nebula is characterized by tortuous dark rifts without stars in them. Those which intersect the denser part of the nebulosity have margins sharply defined, whilst those in the fainter parts are broader, with the margins less defined and some nebulosity in the rifts.

There have been published in KNOWLEDGE, during the past two years, three photographs showing the densely dark rifts, and besides those, others showing the broader rifts; amongst the latter the nebulæ in Orion and in Andromeda are conspicuous examples, as well as those of the cloud-like class.

The inferences we may reasonably draw from these appearances are that those nebulæ are developing into the more stable form of stars by the influence of gravitation. They appear to be the earlier stages in the development of spiral nebulæ, examples of which have been shown on many photographs already published, where it was obvious that the nebulosity is aggregating into stars in the convolutions.

The most useful work that can now be done for the advancement of astronomical science is the careful measurement of the position angles and distances of the sufficiently well defined star-like condensations of the nebulosity in these various nebulæ from selected normal stars, six or eight in number, which surround the respective objects within the radius distance of one degree or less. In this way astronomers would, within an interval of a few years, be able to demonstrate the changes that have taken place in these bodies with reference to those stars as fiducial points; and thus positive knowledge would be gained in place of the speculative with its never ending controversy.

It is welcome intelligence that Dr. Dreyer, of the Armagh Observatory, is about to commence the attack upon this work.

ASTRONOMY AND ASTROLOGY; A QUESTION OF PRIMOGENITURE.

By E. WALTER MAUNDER, F.R.A.S.

No record exists to tell us under what circumstances, and exact form, the science of Astronomy had its first beginning. We can, therefore, but make a guess as to its origin, and most of our leading writers are at one as to the agent which gave it birth. Astronomy, say they, is the daughter of Astrology.

It may seem presumptuous to call in question an idea which writers, of such sound judgment and keen perception as the late R. A. Proctor, have regarded as axiomatic, but, in my own view, Astrology, so far from being the parent of Astronomy, must be looked upon as a late and most degenerate descendant from the sublime science.

Astronomy, like everything else, had a beginning. There must have been a time when men had not yet discovered that the stars seen on one evening held the same relative positions as those observed the next; a time when no planets at all had been recognised, and when the sun and moon were not thought to be of the same order as the other heavenly bodies.

An unintelligent townsman of to-day, who may perchance find himself out in the country on some dark, clear, night, looks up and remarks casually, that "It is a lovely night," and "What a lot of stars there are out," and there his knowledge and recognition of the spectacle end. He knows no constellations, he recognises no particular stars; he has never watched the heavens long enough to discern that they are continually turning round the pole; a planet and a fixed star are both alike to him; the heavens present no problems, give no information to him.

Now this state of things, which we find only too widely prevalent to-day, much to the discredit of our modern civilization, must once have been universal. There was a time when no one could recognise a constellation, because none had yet been mapped out; when none could tell the difference between a planet and a fixed star, because no observations had at that early date been devised for following the movement of the one, or proving the immobility of the other.

XUM

Let us turn, on the other hand, to a consideration of the knowledge which is involved in the exercise of astrological art. Supposing that a modern astrologer were asked to calculate the nativity of some client, he would proceed substantially in the way in which Sir Walter Scott describes Guy Mannering as doing at the birth of Henry Bertram of Ellangowan.

> "He erected his scheme or figure of heaven, divided into its twelve houses, placed the planets therein according to the ephemeris, and rectified their position to the hour and moment of the nativity. Without troubling our readers with the general prognostications which judicial astrology would have inferred from these circumstances, in this diagram there was one significator which pressed remarkably upon our astrologer's attention. Mars having dignity in the cusp of the twelfth house, threatened captivity, or sudden or violent death, to the native; and Mannering, having recourse to those further rules by which diviners pretend to ascertain the vehemency of this evil direction, observed from the result that three periods would be particularly hazardous—his fifth, his tenth, his twenty-first year."

The foregoing sketch of an astrologer at his work will be a sufficiently accurate one for our purpose, no matter what the time or the nation in which he is supposed to have lived.

Now what is involved in the operations which Guy Mannering performed? First of all, they imply that the constellations had been devised and mapped out; next, that the planets were recognised as such, and these are inferences with very significant consequences. The recognition of "the seven planets," though it came so early in the history of the world that there is a numerous school which believes the week is a consequence of such recognition, was no simple matter. It was a triumph of careful observation and clear induction which led the early astronomers to see that Hesper and Phosphor, the evening and morning stars, were not two bodies, but one. Much more difficult was it to track the elusive Mercury, and recognise in it again a single wanderer. Mars and Jupiter would be followed with much greater ease, but the dull and slow moving Saturn could only have revealed itself as a planet when observations of the relative positions of the stars had become systematic and it was known from definite measurement of some sort or another that of all the stars, these five and these alone, moved with respect to the others.

The recognition of the remaining two of "the seven planets" must have been no easy matter, and implies a power of looking behind the mere superficial appearance of things in the highest degree creditable to the early workers in our science. For the effect produced by the sun and moon on the mind of the casual spectator is certainly that of an altogether different order and kind from the stars and other planets. Of course, it was easy to perceive that the moon moved amongst the stars, although its motions differ in several important characteristics from those of any of the planets, but he must have been both a clear and a bold thinker who first told his fellow men that the stars were shining down upon them all day as well as all night, and that the explanations of the changes in the constellations visible at different seasons of the year was that the sun was moving round amongst them in the course of a year, as the moon did within the limits of a month.

All this pioneer work must have been done, and done thoroughly—become familiar and commonplace long before the very first step in astrology can have been taken. Men cannot possibly have conceived that Jupiter brought good fortune, or Saturn sinister, before they had recognised the existence of those planets, and that they moved differently from the common herd of stars.

If we assume that at some early date men had come to look upon certain of the planets as favourable, and others as unfavourable, we can readily see that an Astrologer who could take an actual observation of the heavens at the moment of the birth of some Prince, or of the starting of some expedition, or the laying of the foundation of some building, could come to the conclusion that the person or enterprise would be prosperous or the reverse. But that was not the chief object of Astrology. The principal point was to find out beforehand at what time in the life of the new-born Prince he would be most exposed to danger or most likely to meet with good fortune. This was the actual case with Guy Mannering's prediction of Harry Bertram. So in the event of an expedition, or enterprise of any kind, the duty of the Astrologer was to choose in advance a favourable moment for its commencement. And in both cases this demanded on his part a very precise knowledge of the future position of the planets. A complete horoscope, indeed, involves the knowledge, not merely of the places of the planets that are above the horizon at a given time, but also those that are below. This meant a mastery of the apparent movements of the planets, which can only have been obtained after centuries of the closest observation. In other words, the existence of Astrology pre-supposes a state of Astronomy not less advanced than it was in Alexandria under Claudius Ptolemy, or in Samarkand under Ulugh Beigh.

More than this, Astrology bears witness to a previous Astronomy, then half forgotten. The signs of the Zodiac of the astrological scheme are not in the least the actual Zodiacal constellations, though they derive their names from them. They are simply a method of recording celestial longitude, and bear no relation to the configurations of the actual stars.

Yet whenever and however Astronomy first arose, the initial step towards progress must have been the mapping out of the stars into constellations; until that had been done it was impossible for men to be sure that the stars they could see maintained the same relative positions towards each other. Not until that fact had been assimilated was it possible to appreciate the next, namely, that certain stars were planets, wandering amongst the others. Then when the constellations had been formed, there must have come quickly the recognition that different constellations were visible at varying times of the year, and this led on no doubt at once to the idea of adapting the science to utilitarian purposes.

Both tradition and, it seems to me, the inherent probability of the thing, support the belief that the first use of Astronomy was the determination of the length of the year and the announcement of the return of the seasons in their due course; and this must have been a service of the very first magnitude. For although the early agriculturist could learn from flowers, or plants, or trees when Spring was approaching, yet these phenological indications are somewhat vague and indefinite, and will vary considerably even in neighbouring districts.

No doubt the chief duty of the early priests and astronomers, to whom the task of watching the heavens was intrusted, consisted in noting the heliacal rising of certain special stars to be able to announce the return of the different seasons of the calendar, and in all probability it is in these observations that we can see the

first germ of the notion of Astrology. For the seasons in their course naturally bring with them their own characteristics—seed-time and harvest, cold and heat, drought and flood, fevers and agues, and the like; and it would be easy to associate these various phenomena with special stars, and to ascribe them to the stellar influence.

Such astrology, however, would be a purely stellar astrology, not susceptible of very much development. Astrology, as we know it, on the other hand, is almost exclusively planetary, and very nearly independent of any such simple considerations as the return of the stars to their heliacal rising at the end of the year.

Another application of Astronomy which must have been considerably later than that of its use for the determination of the calendar, and yet which was certainly an early one, is its use in navigation, taking the word in a wide sense to mean not merely the steering of a ship across the sea but also a caravan across the desert. Here it must have been early appreciated that the stars afford absolutely the best finger-posts by which to cross the pathless and monotonous ocean, and no doubt it was soon understood that not only did they give the means for determining the cardinal points but also for ascertaining the latitude of the traveller. The sailor who was thoroughly acquainted with the stars would have no difficulty in navigating from one port of which he knew the latitude to any other whose latitude was also known. He had but to sail north or south until the elevation of the Pole Star assured him that he was on the proper circle, and then he would sail east or west, as the case might be.

There must have been a very wide demarcation in early times between the Astronomy of the Calendar, without doubt in the hands of a small and mysterious cult, and the Astronomy of Navigation necessarily in the keeping of practical sailors. The latter would certainly have not lent itself to astrological ideas, and though we may owe several of our constellations to these early sailors they are not likely to have done much to give the science a fortune-telling character.

Very different indeed would have been the position of the priestly astronomers if by dint of careful observation and research they were able to go beyond their original work of arranging the calendar, and were able not only to divine the causes of eclipses but to foretell them. If they attained to this mastery of the laws of Nature then they had a power in their hands which could be readily used for political or religious effect to an almost unlimited extent, and which would at the same time serve as a foundation upon which an infinitude of further claims might be safely based. To this very day no astronomical feat whatsoever obtains such wide and complete popular recognition as the computation of the time of an eclipse, and in those early ages the occurrence of an eclipse in accordance with prediction must not only have seemed to invest the astronomer himself with superhuman powers, but must have convinced the people beyond all chance of confutation that the movements of the heavenly bodies were intimately connected with the affairs of men. The successful prediction of an eclipse was probably regarded at once as a certificate of the skill of the Astrologer and a demonstration of the reality of Astrology.

Nevertheless, when once the imposture had been fairly set afoot of predicting the fortunes and fates of men from the movements of the heavenly bodies, the predictors must have speedily found themselves short of material upon which to go. The return of stars to their heliacal risings in the course of the year would be far too regular a phenomenon for anything but general prophecies to have been based upon it, and eclipses are too rare for anything but occasional use. The sheer necessity which a fortune-teller would have for a wide range of combinations, applicable at any and every moment, must have driven the old soothsayers and seers to the use of the planets as their stock in trade, directly the science of actual observation had been so far advanced, that they could both predict a planet's place in the future, or calculate back its position in the past. The infinite diversity of grouping which the planets offered, lent itself so precisely to the needs of the imposture that once started the pseudo-science developed with amazing rapidity.

The rise of Astrology would seem to have meant a complete arrest of the development of the parent science —Astronomy. The Astrologer needed his tables of the sun, moon, and planets. He required some instrument for observing the altitude and azimuth of a celestial object. Ability to make at least an approximate determination of time was a desideratum, but given a science which would supply him with this information, and he stood in need of nothing more. He boldly translated the celestial movements into terms of human history, and predicted wars and revolutions, plenty or famines, as the result of the planetary positions. It did not occur to him to follow these positions for themselves or to speculate as to how they were brought about. Had a doubt as to the Ptolemaic system been suggested to him it would, likely enough, have seemed idle and abstract controversy. The astrological significance of a given position of Mars was just the same, whether its real centre of motion was the earth or the sun. Astronomy, therefore, which had made so great a progress before Astrology could have made a start, remained perfectly dormant during the long ages when men studied the heavens not to get a better knowledge of the laws of Nature but simply, if possible, to lift the veil which hid their own future. And when once again men began to inquire as to the real physical meaning of the movements of the planets, Astrology decayed as rapidly as it had grown. The arguments of Copernicus, the telescopic discoveries of Galileo, the laws of Kepler, though they have no direct bearing on the truth or falsity of Astrology, yet by directing men's minds to the true problems which the heavens offer, speedily put an end to the absurd inventions which had enchained men's minds for so many generations.

We are able to indicate roughly how far back both Astronomy and Astrology are traceable. Assume the mapping of the constellations amongst the first of Astronomical operations. Now the old constellations which have been handed down to us through the medium of the Greeks, from the old inhabitants of Mesopotamia, received their completion not quite 3000 years B.C. This we know, since, as has been frequently pointed out, the region in the Southern heavens which the Astronomers of old left unmapped, is one the centre of which coincided with the Southern Pole a little less than 5000 years ago. This then gives us the date of the completion of the constellations. How long they had taken to map out we cannot tell, whether it was a few months, a few years, or several centuries. Yet we can be sure that it was not an indefinitely long time, for whilst many traditions in different forms remind us that Taurus was once the equinoctial constellation, there is no tradition that Gemini ever held that place.

When we come to Astrology, however, we find the

XUM

indubitable marks of a much more recent origin. First of all, as already pointed out, the astrological signs of the Zodiac have nothing to do with the actual stars; the constellations to which they owe their names are left quite out of sight and are almost forgotten. Next, and most significantly, we find that Aries is the primitive sign of the Astrological scheme. There is no hint that it ever had been Taurus. This fact would of itself suffice to show that Astrology, at any rate in any such systematised form as we now know it, is far younger than Astronomy, younger by the time which precession takes to cross an entire sign of the Zodiac, younger, that is to say, by a period which we may roughly put as 2000 years. No doubt sun-worship and moon-worship reach back almost to the birth of the human race; no doubt eclipses, comets and meteor-showers struck terror into men from the earliest ages, and many superstitions and fancies of an astrological tendency took form and shape in primitive times and prepared men's minds to accept the imposture when at length it had attained an organised development; but we can say positively that Astrology in anything like a complete system cannot date back earlier than 1800 B.C., when the sun first entered Aries at the Spring Equinox, and that it must almost certainly have arisen many centuries later.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Of course the academical question, whether the Universe is finite or infinite, is not likely to be solved in our time, and I do not think that the difficulties raised by some correspondents of your journal, and elsewhere, about our idea or conception of the infinite will afford us the least assistance in arriving at the solution. The structure of the Universe is a very different thing from our ideas or conceptions of it.

But the question which occurred to Mr. Burns, and had previously occurred to others, is in reality a different one. It is this: Is the Universe confined within limits which we may reasonably expect to ascertain and define—for instance, within a sphere with the sun (or earth) as centre, and a radius equal to 100,000,000 times the sun's distance from the earth? In fact a sphere with a considerably smaller radius than this would account for everything that we at present know. But although this explanation is admissible, there are grounds for doubting whether it is the true one.

Mr. Anderson, I think, falls into a very common error on this subject, by supposing that nothing can affect the eye unless it can be separately seen. The current theory at present is that Saturn's rings consist of meteors. What would be thought of an astronomer who contended that the ring must be invisible because the meteors cannot be separately seen? Again: look at the Milky Way on a clear, moonless night. It is perfectly visible to the naked eye; but can it be said that our most powerful telescopes, whether used by the eye or on the photographic plate, have as yet resolved all this luminosity into separately visible stars? The zodiacal light and the Gegenschien may be cited in further illustration of this. Stars or other objects, which no one has as yet succeeded in rendering separately visible, do unquestionably affect the naked eye; and if we find that the general illumination of the sky falls much short of what it ought to be on any given theory, we cannot explain this fact by supposing that stars of less than a given magnitude produce no effect at all. Take a single meteor at the distance of Saturn and of the average size of those which compose the rings; regard this meteor as a star, and of what magnitude will it be?

Bright stars lose as much by absorption, atmospheric or telescopic, as fainter ones. Hence, we may neglect the element of absorption when dealing with the total light of stars of different magnitudes. It is, of course true that "if the illuminating area were to decrease, owing to increase of distance, more rapidly than it increased owing to greater numbers... it would never give us a blazing sky," as Mr. Hill says. But this could not occur without a constant thinning out of the stars as we pass to greater distances from the solar system. On the hypothesis of uniform distribution, when the light of the stars decreased in the proportion of 2.512 to 1 (one magnitude) the number would increase in the proportion of 3.984 to 1, and the total "illuminating area" would be more than $1\frac{1}{2}$ times as great as before. Mr. Burns, I apprehend, did not seek to prove that the stars could not extend to infinity. What he sought to prove was that they could not do so unless there was a constant thinning-out on the way. The question is almost equivalent to this: Is the sun a member of a star-cluster?

Admitting, however, that the sun is a member of a cluster, the chances are that it is not in the centre of the cluster; and, if so, this thinning out of the stars ought not to take place at once. But if we take in the entire sky, as far as I can judge, the apparent thinning-out begins almost at once. Hence the existence of an absorptive medium of some kind in space is naturally suggested.

W. H. S. MONCK.

LUNAR SEAS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I hope Mr. Tepper's very thoughtful paper and Mr. Tappenden's letter in your last issue will revive an interest amongst your readers in the study of lunar cosmogony.

The theory suggested by Mr. Tepper has so many things in its favour that I cannot think it unimportant; the fall of meteors on its surface, where no atmosphere exists, certainly suggests a plausible origin for the rays from Tycho and other ring craters as we call them. I am not sure but some of the craters themselves may have originated by the fall of large meteors coming down vertically into a deep coating of such dust as Mr. Tepper speaks of, and might explain the radiating rays, whilst meteors moving obliquely would explain the rays which run parallel to each other, and there are many such.

The large plates of the French photographs by Loewy and Puiseux will be of very great value in the study of lunar questions; the part of one of these published in December KNOWLEDGE shows many important points, which answers some of the suggestions. The ray below Bullialdus (E) does not run into the crater Tycho but passes close to its eastern wall, and can be traced running in the same direction on the other side, and we can easily trace another ray running parallel to it farther east, as if a meteor had ploughed through some loose matter, forming a furrow and throwing the material on

each side of its track. There is also another running parallel with these on the west side of Tycho. It appears to me as if a number of meteors swept over this part of the moon in the same direction at the same time.

Mr. Maunder speaks of Kies and Lubiniesky as having sunk in the invasive fluid. May it not be that these rings were perfect before the rays referred to were formed, and that the matter thrown from the meteor's track has buried these rings?

Another group of parallel rays sweeps north westerly from Kircher and Bailly, over Tycho and on to Lexell. I think Mr. Tappenden's suggestion that the rays are the results of meteor flights and falls may be the true explanation.

December 17, 1899. A. ELVINS.

S. S. CYGNI.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—We have had a remarkable appearance of S. S. Cygni during the last two weeks, quite unknown to our experience. For myself I will say I did not believe my eyes, and sought for light, but my observations which are as follows have been fully confirmed:—

1899.		Mags.	1899.		Mags.
Nov. 21.	Cloudy		Dec. 1.	9 p.m.	9·20
„ 22.	7.30, 8 & 9 p.m.	10·5	„ 2.	8 p.m.	9·20
„ 23.	8 p.m.	<10·00	„ 3.	7.45 & 9 p.m....	9·25
„ 28.	„	9·37	„ 4.	7.30 p.m.... ...	9·30
„ 29.	„	9·30	„ „	9 p.m.	9·35
„ 30.	„	9·20	„ 5.	7.30 p.m.... ...	9·55
			„ 6.		<10·00

The weather since has been cloudy. The maximum may be put on the 1st December. The star on previous apparitions rose on second or third nights to about 8.5m.

DAVID FLANERY.

Memphis, Tenn., U.S.A.,
9th December, 1899.

Obituary.

JOHN RUSKIN, whose death, on the 20th January, 1900, we regret to record, was born in 1819, the son of a wine merchant in London, and was educated privately and at Christ Church, Oxford, carrying off the Newdigate Prize. His love of art found expression in his early attempts at painting, and in the pamphlet written by him in defence of Turner and his method, which was afterwards expanded into the great work—"Modern Painters," the five volumes of which, illustrated by himself, appeared between 1843 and 1860. "His besetting sin," says Frederick Harrison, "as a master of speech, may be summed up in his passion for profuse imagery and delight in an almost audible melody of words." Indeed, it is generally conceded that Ruskin not only surpassed every contemporary writer of prose, but called forth out of our English tongue notes more strangely beautiful and inspiring than any ever yet issued from that instrument. "No writer of prose before or since has ever rolled forth such mighty fantasies, or reached such pathetic melodies in words, or composed long books in one continued strain of limpid grace." "All my life," he once said, "I have been talking to the people, and they have listened not to what I had to say, but to how I said it; they have cared only for the manner, not the matter. For them the kernel is nothing; it is the shell that attracts." In 1849 appeared his "Seven Lamps of Architecture," followed by "The Stones of Venice," 1851-53; "Lectures on Art," 1859; "Unto This Last," 1862; "Ethics of the Dust," and "Sesame and Lilies," 1865; "Crown of Wild Olive," 1866, and others. Ruskin was Slade Professor of Art at his own University, and Rede Lecturer at Cambridge. His autobiography, under the name of "Praeterita," appeared in parts a few years ago. The venerable Dean of Westminster offered to the relatives a space in Westminster Abbey in Poets' Corner for the entombment of the great critic and philosopher, but, adhering to Mr. Ruskin's previously expressed wishes, the distinguished man of letters now rests in the churchyard at Coniston.

It is with much regret that we have to record the death of Dr. ELLIOTT COUES, the well known American Zoologist, who died at Baltimore, on December 25th, aged 57. Dr. Coues began life as a surgeon in the U.S. Army, in which position he had unusual opportunities for travel. The results of his collections of birds and animals made during these expeditions were published in various scientific journals. In 1872 he published a most valuable "Key to North American Birds." Among his other works may be noted, "Birds of the North-West," "Field Ornithology," "Birds of the Colorado Valley," and in conjunction with Mr. J. A. Allen, "Fur-Bearing Animals." Dr. Coues was best known as an ardent and accomplished ornithologist, not only in America but also all over Europe. As a man he was most genial and affable, and his loss will be a great one, as well to his friends as to the scientific world at large.

Notices of Books.

A System of Ethics. By Friedrich Paulsen. Edited and translated from the fourth German edition by Frank Thilly. (Kegan Paul.) 18s. net. Since, as Matthew Arnold wrote, "Conduct makes up three-quarters of life," the science concerned with studying and formulating the laws which govern right conduct is of the very highest importance. We welcome Professor Thilly's translations of Professor Paulsen's valuable contribution to this study, because being written primarily for those who are personally interested in the problems of practical philosophy and not for the philosophical expert, it can be easily understood by the ordinary intelligent person who reads carefully. The translator has used a wise discretion in omitting certain sections of the original treatise which only possess a more or less local interest for the German public. The first portion is devoted to the historical development of the conceptions of life and moral philosophy from the times of the Greeks down to the present; the next examines the fundamental questions of ethics; while the third division of the book is concerned with the application to daily conduct of the principles previously discovered. It will serve to indicate roughly the author's philosophical position if some of his views on crucial questions are briefly stated. He is an advocate of the *teleological* as opposed to the *formalistic* view of the difference between good and bad—that is to say, from Professor Paulsen's point of view, "acts are called good when they tend to preserve and promote human welfare; bad when they tend to disturb and destroy it." To the question, "What is the end of all willing?" the *energistic* and not the *hedonistic* answer is given. "Not pleasure, but the 'objective content of life' is the highest good at which the will continually aims." "The highest good of an individual as well as of a society consists in the perfect development and exercise of life." Nor is the author a pessimist; in one place he says, "philosophical pessimism is not a proved theory, whose propositions can lay claim to universal validity, but the expression of individual feelings, and as such can be merely subjectively true." Or, again, "inasmuch as we have no statistics on the happy and unhappy lives, the successes and failures, I am for the present inclined to put as much faith in

the judgment of a plain man of the people as in the eloquence of a pessimistic philosopher." But interesting quotations could be multiplied indefinitely. When it is said that some of the headings of separate chapters are "Duty and Conscience," "Virtue and Happiness," "Relation of Morality to Religion," "Suicide," and "Justice," it becomes abundantly evident that the volume is brimful of information interesting to every thoughtful man and woman, and as, added to this, the translator has succeeded throughout in writing clear and pleasing English, it is quite certain that the book will be widely read.

Impressions of America. By T. C. Porter, M.A. (OXON.). Illustrated. (C. Arthur Pearson, Ltd.) 10s. 6d. Mr. Porter tells in simple, chatty language, the story of a hurried visit to America. He travelled from New York to Niagara, thence to the Yellowstone Park, San Francisco, Yosemite, Utah and the Colorado Springs. The author is not strong in painting word-pictures, indeed, his pen sometimes halts rather painfully, but yet the narrative as a whole is quietly pleasing. At the same time a great deal of information about the show-places of America can be learnt from the book, and Mr. Porter's experiences cannot fail to be useful to anyone who intends taking a holiday of a similar kind. The reader's attention is directed almost entirely to scenic effects, examples of earth sculpture, and kindred topics. The ways of men in these western places are scarcely touched upon at all. The most noteworthy characteristic of the volume is undoubtedly the fine collection of stereoscopic plates which accompanies the text, and a stereoscope is supplied with the book for the proper examination of the plates. Though Mr. Porter's clear explanation in the introduction will enable many readers to obtain the stereoscopic effect without any instrument, the person who objects to a little preliminary trouble will be glad of this novel addition to the volume.

The Universal Illusion of Free Will and Criminal Responsibility. By A. Hamon. (University Press, Limited.) 3s. 6d. Criminal anthropology, in the hands of Professor Lombroso's followers, is advancing rapidly. Sociology and psychology constitute very plastic materials out of which these students can mould ethereal forms not altogether agreeable to the average citizen of the world. Sample: "The criminal is normal, and the honest man an anomaly. I defy the refutation of this assertion if, by criminal, is meant the author of an injury to the community or to an individual." For an acquaintance with the multitude of facts put forward to uphold such assertions as this the book itself must be consulted. We are, according to the author's teaching, practically automatons. Marriages, crimes, suicides, emigration, births, mortality, and so on, are the resultants of many forces—social, physical, and cosmic. Free will, the helm by means of which some of us imagine we steer the human ship, is denied.

The Romance of Wild Flowers. By Edward Step. (Warne.) Illustrated. 6s. No pleasanter companion could very well be imagined than Mr. Step in his communings with Nature. Roses and apples, buttercups and columbines, violets and pansies, harebells and heather, all these give pleasure as the eye glances down the pages, and the pictures almost emit the sweet odours which the plates recall to the memory. It is a book to put flower lovers merely on speaking terms, as it were, with Nature, and is not intended for the scientific botanist.

An Introduction to the Study of Zoology. By B. Lindsay. (Sonnenschein.) Illustrated. 6s. Students of biological science are too frequently retarded at the outset through lack of information concerning the means necessary for amplifying their knowledge outside the very limited scope of a first book on either of the two branches of the science—zoology and botany. Mr. Lindsay has anticipated these difficulties by chapters on the use of books, biological stations which have been established on the British coast for the study of marine biology, lists of persons who can supply specimens and tools to work out the practical details, and so on. All this, added to the usual text, raises Mr. Lindsay's book to a high level among introductory works of this kind.

The Reliquary and Illustrated Archæologist. Vol. V. 1899. (Bemrose.) 12s. net. We are pleased to observe that this quarterly continues to sustain the reputation it has so long enjoyed as a first-rate magazine of antiquities. The editor, Mr. J. Romilly Allen, merits the thanks of all interested in the survivals of ancient usages and appliances. The rich store of information here gathered together from many and widely separated sources for our quiet enjoyment at home without the trouble and inconvenience of travel are a real boon. The contents vary from a glass linen smoother to a cathedral, and from a tiller of the soil to a Roman Emperor.

Matter, Ether, and Motion. By Prof. A. E. Dolbear. (S.P.C.K.) It would be stimulating to find a new book on Matter, Ether, and Motion which contained a few new ideas—lead us a little way out of the beaten track into fresh fields of thought. Alas! it is still in the parched desert and the twilight that we follow Prof. Dolbear. Matter, for example, is defined as "whatever possesses the property of gravitative attraction." Now, the author adopts this definition in place of "whatever occupies space," but while he may gain a little as regards accuracy, the bewildered student is transferred as it were from solid earth to a base of operations situated somewhere near the centre of the universe. The migration is in the direction of that abstract mood in which Emerson may have been when a millenarian told him the world was coming to an end next day—"I can get along very well without it," said the philosopher.

Living Pictures. By Henry V. Hopwood. (Gutenberg Press, Ltd.) Illustrated. 2s. 6d. net. Here we have a complete compilation of the many facts which have led up to the production of so-called living pictures. From the fundamental persistence of vision, through colour tops, wheel phenomena and the photo revolver, to the various forms of camera now used and the treatment and production of films—all are gathered here in handy shape, and very useful digests of patents and an annotated bibliography give to the book features of permanent value. There are nearly three hundred illustrations, and a very complete index.

BOOKS RECEIVED.

Practical Exercises in Elementary Meteorology. By Robert De Courcy Ward. (Arnold.) Illustrated.

Unwin's Chap Book, 1899-1900. (Unwin.) Illustrated. 1s.

Letter-, Word-, and Mind-Blindness. By James Hinchelwood. (Lewis.) 3s.

Annual Report of the Board of Regents (Smithsonian Institution) for the year ending 30th June, 1897.

Life and Happiness. By Auguste Marrott. (Kegan Paul.) 2s. 6d. net.

British Dragonflies. By W. J. Lucas. (L. Upcott Gill.) Plates. 31s. 6d.

Discoveries and Inventions of the Nineteenth Century. By Robt. Routledge. (Routledge.) Illustrated. 7s. 6d.

Missionary Travels and Researches in South Africa. By David Livingstone. (Ward, Lock & Co.) Illustrated. 2s.

Journal of the Society of Comparative Legislation, December, 1899. (Murray.) 5s. net.

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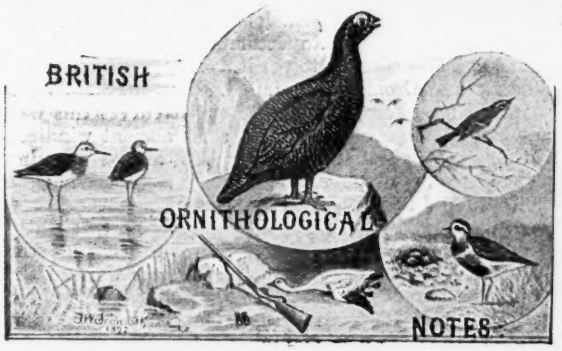


Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

SNOW GOOSE IN IRELAND.—At the meeting of the British Ornithologists' Club, held on November 22, 1899, Dr. Bowdler Sharpe exhibited, on behalf of Mr. R. J. Ussher, a Snow Goose (Chen nivalis), shot near Belmullet, County Mayo. The specimen belonged to the larger form. Although the snow goose has been identified by competent observers we believe that it has never yet been obtained in England or Scotland. Several specimens have been shot before in Ireland, but according to Mr. Howard Saunders they all belonged to the smaller form. Both forms of the Snow Goose are inhabitants of North America.

Grasshopper Warbler in Morayshire. (*Annals of Scottish Natural History*, January, 1900, p. 48.) Mr. R. H. MacKessach has obtained nests and eggs, which have been identified by Mr. Harvie-Brown, of this species from near Elgin. This record seems to extend the northern breeding range of this bird in Great Britain.

Bee-eater in Shetland. (*Annals of Scottish Natural History*, January, 1900, p. 48.) A Bee-eater, which had been seen flying about at Symbister, was found dead by Mr. Arthur Adie on June 5th, 1899. The Bee-eater very rarely occurs in Scotland.

Pratincole near Montrose. (*Annals of Scottish Natural History*, January, 1900, p. 51.) Mr. J. A. Harvie-Brown records that Mr. Stormond shot a Pratincole at Rocksands, Montrose, on November 4th, 1899. The Pratincole has only once before been noticed in Scotland, viz., at Unst, Shetland, as far back as 1812.

Montagu's Harrier in Wicklow. (*Irish Naturalist*, January, 1900, p. 21.) Mr. Edward Williams records that an immature male of this species was shot near Kylebeg, Blessington, Co. Wicklow, on September 7th, 1899.

Rose-coloured Pastor in Co. Mayo. (*Irish Naturalist*, January, 1900, p. 22.) Mr. Robert Warren records that a female specimen of this erratic wanderer was shot near Foxford, on November 5th, 1899.

THE BURIED ALPS.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., Professor of Geology in the Royal College of Science for Ireland.

IT is now well recognised that the granitic core of a great mountain-chain is not in itself the cause of the elevated highland. It has not forced itself up, splitting asunder the superincumbent strata, and hurling them back on either hand; but it bears in its own structure all the signs of stress and pressure, and has clearly been elevated with the strata, along some line of wrinkling in the crust. Here and there, remelting has gone on in the core, as the old rocks moved upward from Precambrian resting places; at other places fresh molten masses have intruded from some caldron far below. Along the axis of movement, the old crust has been squeezed together like a sponge; the liquids have escaped from one hollow to another, and at last consolidated as crystalline igneous rocks, destined to weather out in resisting peaks and pinnacles. The great arch, as it rose, became the natural receptacle for most of these flowing masses; hence, when denudation worked against the chain, these reconstituted types of the fundamental rocks—ancient gneisses that had renewed their youth, began to stand out pre-eminently as a great central ridge. The stratified covering was swept from them, and is now found only in the foot-hills, where its very structure, consisting of folded layers, still renders it an easy prey. Rain and frost work in along the upturned bedding-planes; and the strained masses are always ready to slip and settle down before the earth tremors that still attack the chain.

The central core, then, marks out the axial character of the mountains; where, on the other hand, it has not been pushed sufficiently towards the surface, the features of the foot-hills may prevail from side to side of the wrinkled area. Thus it is that, as we approach the end of a chain, the scenery is less austere and more broken up into local landscapes—not so generalised as in the grander altitudes of the range.

This becomes markedly felt in the eastern borders of the Alps, where the hills ramify like huge fingers, grasping between them the inlets of the European plain. At times we scarcely realise the presence of the massif, the potential mountain-range, though all the time it lies buried at no great depth beneath us.

We leave Vienna by the Cainozoic ridge of Schonbrunn, and are practically entering, from a geographical point of view, on the great Karpathian ring, which girds about the whole of Hungary. On our right, the green but broken highland, covered with its woods, represents alike the limestone Alps of Innsbruck and the forest-ranges of the Tatra which dominate, far in the north-east, the hamlets of the Polish plain. Similarly, the gneissic axis south of us, peeping out along the Leitha Hills, forms the neck that unites the Hohe Tauern of Salzburg with the mining district of Hungary, and, farther still, with the wall-like frontier of Roumania.

There is little, however, to suggest the Alps or the Karpathians in the gentle slopes above the Leitha. The ground rises, that is all; and the first dusty levels of Hungary, where the great white cattle feed in unbounded fields, pass into a more tumbled country, shaded here and there by trees. The villages occupy the strategic positions on this miniature mountain side, with an occasional ruined tower, holding a pass some 600 feet above the sea. Then we descend into the yellow dust again, with the grey waters of the Ferto Lake (Neusiedler See), filling its basin on the left. Even this lake emphasises the contrast with the Alps; it is ten miles long and about four feet deep, saline itself, and bordered by still salter marshes. This is clearly a feature of the plain, into which it often merges by evaporation.

Continuing southward, we actually touch the gneiss, on a little rise beyond Sopron (Odenburg); and we get under a real hill at Koszeg, the last spur of the north-eastern Alps. Then, for kilometre after kilometre, we cross a low plateau, formed of crumbling Pliocene and Miocene strata, among which are the last marine deposits laid down in Eastern Europe. Every now and then, we descend into an alluvial area, cross some stream running eastward to the Danube, note the villages clustered thirstily along it, and push up again to the yellow scarp of the plateau.

But in time the alluvium becomes the prevailing feature. At Baksa, the country is so level that a tall

XUM

pole, with cross pieces nailed to it, is set up in the village, so that the watchman can ascertain the locality of a fire, when roused by the glow against the sky. The brown acres are ploughed from the roadside to the horizon, and the farmer can view his twenty-two pairs of oxen moving, at wide intervals, across one even field (Fig. 1). The little towns exist purely for the cultiva-

Fig. 1. Ploughing in the Plain of Western Hungary.

tors of the soil, and a market-day clears the country round. In the afternoon, however, the peasants will stream out again, hundreds of swaying rustic carts will follow one another down the road; and the clear gold sunset, a veritable sunset of the plains, will add its colour to the crimson and blue and orange of the dresses of sober matrons, or to the white kerchiefs of bronzed and laughing girls.

We are, in fact, approaching the first of the great Alpine rivers; for at Lendva we enter on a valley, which varies from 7 to 16 kilometres (10 miles) in width—a valley choked with sand and pebbles, spread out by successive shiftings of the stream. Against the southern bank, which is at present favoured, the Mur runs among its sandy shoals. Here, in the middle of a continent, the river already lies only 160 metres above the sea; and it shortly lets its waters slip, as if exhausted, into the greater current of the Drava.

How should we know this river, this lowland Mur, for that which we have seen in flood through Styria, tearing at its banks, washing away roads and houses, rejoicing to run its course among the shattered forests of the Alps? Or is it the same that flows at its birth through all those resonant ravines, as we come down from the crags of the Tauern, where the chill clouds move against the walls of rock, and feed each night the growing streamlets in the clefts? Truly, the rivers depend for their life upon the mountains; and they are always undoing themselves, wearing away their gathering-grounds, and choking up their own courses in the lower reaches of their valleys.

There is quite a ridge, comparatively speaking, between the Mur and the Drava. In this level country it is an incident in itself, though the summit lies about as high as Richmond Hill above the Thames. Beyond it is the flat in which the Drava wanders. Here we have a river indeed, with a long course yet before it; but it divides already into a number of loops and backwaters, and all attempts to use it as a boundary between Hungary and Croatia have failed. You may see upon a detailed map how the official frontier curves this way and that, representing, no doubt, some ancient windings of the stream; but new routes are always opening among the alluvial islets, and a fringe a kilometre wide on either hand is abandoned to the chances of the floods. The river, in its numerous channels, flows silently between banks of grey-green willows, which hide the water until we are close upon it. At last we find the main artery, spanned by a long iron bridge; we are now again only 160 metres above the sea, which lies at Varna, as the crow flies, 600 miles away.

The Drava, traced back as the German Drau, has done its work at higher levels. It rises at a height of 1300 metres among the stone-slides and fir-woods of the dolomites of Toblach; we may follow it, reinforced by noisy brooks, through the flood-swept gorge of Lienz, one of the most impressive scenes of rock-destruction to be found in the whole of Europe; we may see it swirling the timber-rafts upon its bosom through the ravine of Sachsenburg, and then emerging, with an air of innocence, among the maize-fields and farmsteads of Paternion. Soon, where the clear green Gail flows into it, we hear of it as the Drava, in the soft and grave Slavonic speech. It cuts its way for another eighty kilometres to Marburg in Styria, often lying deep between vertical walls of rock; and then ultimately it becomes wearied, and covers the country to Varasdin and the Danube with the spoils of Karinthia and Tyrol.

In fact, these great eastward-flowing rivers have worn their way down practically as far as they can, and have reached almost the same levels in the plain; and now, as their flow becomes more sluggish, they may even tend to raise themselves on their own alluvium, instead of cutting out a groove in it. Their history has been much the same; doubtless they began to flow when the Alps at first arose; and they may thus have fallen at one time into the late Miocene sea of eastern Europe. Soon, however, this sea was banked out by continued uplift of the land; brackish and fresh-water lakes replaced it in the west of Hungary; and then these also disappeared, their floors being raised against the cutting action of the streams. A number of shallow valleys have now been excavated, and the rivers from the Alps, with the spread of the continent, have grown longer and longer towards the east. The removal of matter from Styria and Karinthia to the plains has been going on since early Pliocene times. The pebble-beds that we have traversed on the plateaux contain all manner of old rocks, quartzite and schist and gneiss, clearly derived from the central portions of the chain; and all this detritus has filled up pre-existing hollows, and has buried deeper than ever the unseen prolongations of the Alps.

If, however, the invisible ridges below us continue to rise, the period of deposition may pass away. But are upward movements in progress, or is merely settlement going on? In Switzerland, the conversion of long mountain-valleys into lakes, such as those of Lucerne and Como, points already to a sinking of the central massif. But this indication of old age is absent in the younger ranges to the east; and Switzerland was already high and dry when Italy and parts of Austria-Hungary lay still beneath a Cainozoic sea. Hence elevation may still be going on in the east, and the

buried Alps may be destined to play their part in Europe.

The frequency of earthquakes in the area under consideration shows at least a condition of unrest. In Agram, the Croatian capital, shocks are felt about twice a year; and the city was in great part destroyed on November 9th, 1880. Still more recent examples are the Bosnian earthquake of 1891; the great Servian shocks in 1893; the destructive earthquake of Laibach on April 14th, 1895, when twenty-five shocks were felt, and when tremors were noted at Vienna and Trieste, at Salzburg, and at Agram in the east. In 1897, Laibach was visited by a smaller, but also destructive, earthquake; and a comp ete series of observatories would probably reveal, as Dr. C. Davison has remarked, the extreme instability of the region that stretches from Karinthia to Constantinople.

At present, the alluvial features of the Drava Valley give Verasdin the appearance of a city in a plain. But in the south a long range of wooded hills can be descried, a welcome change from the bare Hungarian levels. These broken ridges, in parts as lofty as the Grampians, lie in the direct line of the Carnic Alps of Tyrol and Venetia. Now and again, as we cross them, a little scarp of grey limestone among the trees serves as a reminder of the superb rock-giants that gather on the wall of Italy. But the peaks of Cortina and the canons of Auronzo are remote indeed from this warm and cultivated upland. The clustered woods give way to parks and farmlands; there is one more pass, with a show of romantic interest, whereby we rise to 208 metres, or not quite 700 feet above the sea; and then we have a long fall to the valley of the Sava, and the crossing of the Alps is an accomplished fact. In a traverse of some forty miles, we have ascended, as it were, to the level of the Surrey Downs, and have completed our passage of one of the structural lines of Europe.

The diversity of rocks, however, in this model of the Alps, has given us a corresponding change of scenery; and the noble Sliemen range above Agram in no way disappoints the eye. Even the crystalline schists of the core crop out at the north-east end of it, flanked by little patches of Cretaceous limestone, such as are uptilted in Switzerland to form heroic crags. It is evening as we come down into Agram, in the shadow of these steep grey hills; and far away in the west we can see the huge ridges of the limestone Alps themselves, a vision of purple and pale gold, against the lurid glory of the sunset.

Next morning we cross the Sava, on a long bridge that seems to lead into a limitless expanse of level cultivated land. The river flows through its own brown alluvium, a mere magnification of the Raba, or the Leitha, or other streams that open out on the fringe of the Hungarian plain. Once in a while a hamlet, or one of the old eastern wells, provides an incident for the eye; elsewhere we move between the maize-crops, their stems seven or eight feet high, effectually walling in the road. Sometimes in the open, we see the clouds gathering on the fine mass of the Sliemen, and the towers of Agram falling back behind us in the shade. And yet this Sava has also had its day of strength and energy. For it rises in a wild and craggy highland, close against the valley of the Gail; the limestone fortress of the Mangart guards it from the southern sun; and the great grey blocks, split by frost from the wall of Italy, form the first boulders in its stream. A straight line from its source to Agram, where it leaves the highlands, measures two hundred kilometres, or more than one hundred and twenty miles.

Through southern Croatia, the villages are artificially protected from floods, and the roads along the rivers run upon embankments. The same precautions, often futile, have to be taken here, as in the Danube plain itself. The bends of the river are thus, through artificial aid, a little more stable than they were in former times, and strenuous efforts are made to keep the water within bounds. Beyond Sisek, the old loops and backwaters become more frequent, and strangely curved villages diversify the scene, their form having been originally dictated by bends of the river which has deserted them. Elsewhere, the houses cluster along the first terrace of the hills, their bases washed by the alluvium, as by a sea; the great highway of the "military frontier" runs towards Turkey on the outcrop of the Pliocene strata, and the villages have grown out along it from north-west to south-east, until some of them stretch for five kilometres along the road. The great flat between them and the river is given over to marsh-land and oak forest (Fig. 2); and the country has a poor and desolate air, much as if it were still swept by the Turkish irregulars of a hundred years ago. The only offshoots of these elongated villages lie in the tiny valleys of the lateral streams, where huts piled indiscriminately, and half hidden in the trees, climb up along convenient watercourses.

FIG. 2. In the Oak-Forest of Vukovina, alluvium of the Sava.

When, at any point, we have to cross the alluvial plain, we may feel at once the shelterless nature of the country. All the morning, the storm has been creeping nearer. The black gloom that gathered in the Agram hills has blotted out the distance with terrific and truly inky thunder-clouds. As we turn round, kilometre after kilometre, we can feel the sunlight being swept from the face of heaven; the earth lies still; even the great oak-forest, from which we have emerged, is only just beginning to tremble in its topmost leaves. But now the first wind touches us, the first drops begin to fall; the whole life of the country is at once in motion, fleeing along the road, where the dust is whirled up strangely amid the rain. Hailstones descend, at least an inch across, and break themselves to pieces on the ground. Horses, cows, poultry, white-kerchiefed girls,

XUM

and men in black coats, their sleeves flying out behind them, hurry into the nearest villages from the blank and stricken fields. Up in the Alps you may crouch beneath a rock and see the lightning leap from scar to scar, and hear the church bells ringing out their answer from the fields a thousand feet below; but here, in the great open, the elemental forces will hold you more securely in their grasp. A hand, as it were, at first gentle, then imperious, pushes you forward from behind. In the air there are resistless spirits; in the oak-forest there are strange whisperings, and the cry of frightened birds. The herd-boy, with his rustic pipe, knows these things better than the wisest student of geography.

LONG WAVES OF WINTER WEATHER.

By ALEX. B. MACDOWALL, M.A.

THE student of weather uses various time-units; hours, days, months, seasons, years, &c. Each of these is a grouping of smaller units; and proceeding further, he may compare groups of five years, or ten years, or more. This is often instructive; and it is still better, in the case of a given year-group, to compare, not merely successive groups of that order, but overlapping groups, e.g., in the case of ten-year groups, not merely 1841-50, 1851-60, etc., but 1841-50, 1842-51, 1843-52, etc. Here we come to the principle on which curves are often smoothed. Instead of observing how a given element varies from year to year, we note how the average of three, of five, of ten years (or more) varies from year to year. (The principle obviously applies to smaller units also.)

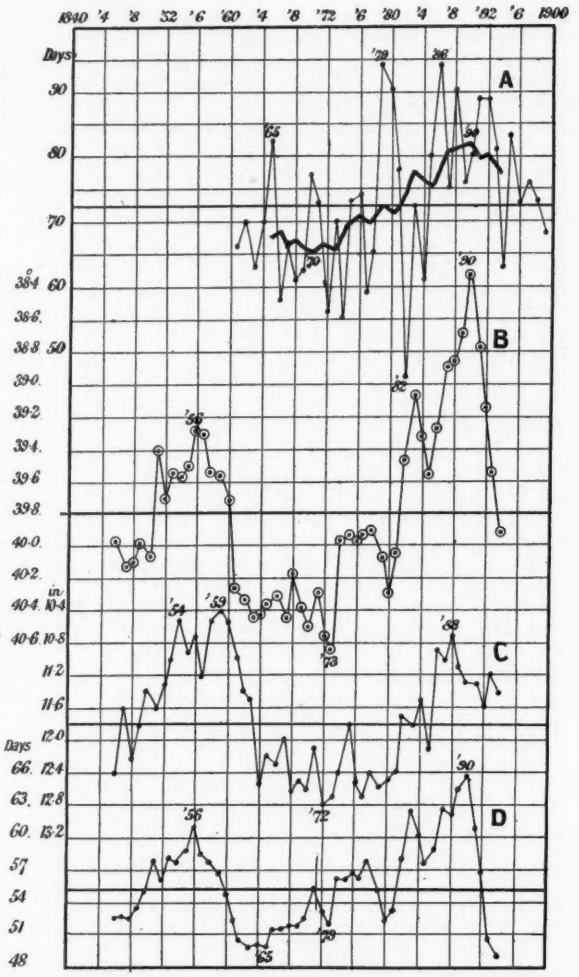
Some interesting relations are thus brought out; and light may be thrown on those longer waves of variation, which often underlie, and are rather obscured by the minor undulations.

In this paper, I propose to look at winters in groups of ten. The term "winter" will be used somewhat loosely, and winters may be briefly denoted by the year in which they end (1842, e.g., meaning 1841-42).

Let us begin with wind in the winter-half (October to March). Taking the Greenwich tables of wind-distribution in which all winds are reduced to the four cardinal directions, we may ask, How many days of northerly and easterly wind (the two colder directions in winter), occurred in each of the winters from 1860? The reply appears in the zigzag curve A. This is traversed by a thick line curve, each year-point of which represents an average of ten; e.g., the first, 1865, the average of 1861-70; the second in 1866, that of 1862-71, and so on. This average, it will be seen, rises on the whole, from a minimum in 1870 to a high point in 1890. That is to say, in the ten winters about 1870, little N. and E. wind; in those about 1890, much.

Next, as to temperature. B is a curve derived from that of the mean temperature of the group of four months December to March, since 1842, by the same averaging process. It is an inverted curve; the high points meaning low temperatures, and the low ones high. Here we find two conspicuous wave crests 1856 and 1890, while a minimum (maximum of mildness) appears at 1873.

Thirdly, rainfall. In the coldest parts of the year, severe cold and dryness are generally associated, while great mildness often goes with wetness. Treating the rainfall of October to March in the same way, we get the (inverted) curve C; and it is not surprising to find a general similarity to that of temperature. The ten-winter groups about 1856 and 1890 ('88 the highest point), show a deficiency of rainfall; those about '73 ('72) an excess.



A. Days of N. + E. wind in October-March (Gr.), smoothed with averages of 10. B. Mean T. (Gr.) in December-March, smoothed. C. Rainfall, October-March (Gr.), smoothed. D. Frost days, September-May (Gr.), smoothed. B and C are inverted.

Lastly, frost days in September to May. The curve D, obtained in the same way, agrees with B in its maxima (of cold) at '56 and '90; but the dip between reaches its lowest point a little earlier, in '63 or '65.

We have, then, the outstanding fact, of a great peak, or wave crest, of cold about 1890; the ten-winter group 1886-95, being the coldest of all the 49 groups considered. That group is also conspicuous for its quantity of N. and E. wind, and shows less than the average precipitation. It may be useful to look at those ten winters, from the standpoint of frost days. The average in September to May being about 55, we have the following numbers and relations:—

	'86.	'87.	'88.	'89.	'90.	'91.	'92.	'93.	'94.	'95.
Frost days ...	75	80	90	60	45	82	73	48	42	62
Relation to average	+20	+25	+35	+5	−10	+27	+18	−7	−13	+7

Thus we see that seven out of those ten winters were severe; that 1888 had the largest number of frost days; and that 1890 itself was one of the three mild

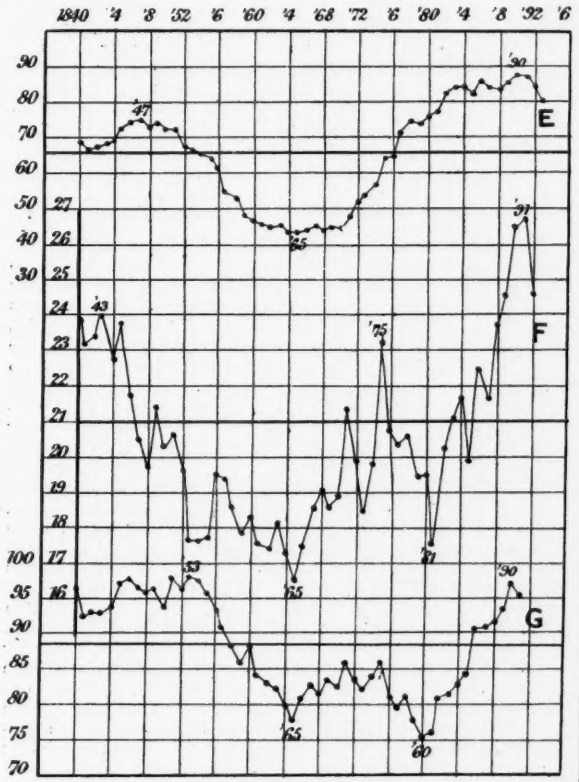
winters. Those ten winters show a total of 657 frost days, being 107 over the average.

In the ten-winter group about 1856, seven out of the ten were also severe; but the total excess was only 60. At the minimum '73, we find six winters mild and four severe (total deficiency 28).

This pronounced peak of cold (about 1890), how is it to be accounted for? Speculation seems vain, till we know more about ocean currents, cosmic influences, and other things.

Then, there is the other crest of the curve in 1856; and we may note the fact, that its distance from 1890 is just 34 years, reminding us of Bruckner's period, with an average of 35 years.

Once more, we find that in the sixties and seventies, the cold of those ten-winter groups is generally slight, while the N. and E. wind gives way to more genial currents, and rain is abundant. A prevalence of northerly wind, it may be noted, probably corresponds with frequent areas of high pressure in the west of these islands, and a prevalence of easterly winds, with high pressure systems in the north (the circulation in such areas, in our hemisphere, being with the hands of a watch). Many interesting points in the behaviour of such systems have been lately brought out by Van Bebber.



E. Frost days in heart of France, smoothed. F. Very cold days, Geneva, smoothed. G. Frost days, Geneva, smoothed.

It may be interesting if we turn for a moment to look at the state of things on the Continent. E is the curve derived from that of frost days in the heart of France (Parc de Baleine), and G the same for Geneva (with different scale); while F represents very cold days at Geneva; days, viz., in which the thermometer did not rise beyond freezing point. All three are obtained in the same way as before, each point representing the average of ten years. These curves all show a long trough between two high waves as before; the later waves in each case culminating about 1890 or 1891, as in London; but the earlier wave somewhat earlier than in the London curves. Further details may be left for the consideration of the reader.

Reverting to the London curves, do they throw any light on the future?

If we take the curve B as roughly representing Bruckner's period of 35 years, and accept his evidence showing that this period may be traced back in one way or another through about two centuries at least, we might perhaps reasonably look for some kind of repetition of the descent from 1856 to 1873 (i.e., 17 years), bringing us to a minimum about 1907; this being followed by a general rise to another maximum about 1924.

We are evidently now in a period of declining cold; and the decline in those averages has, so far, been rapid. We can hardly suppose this decline will be continuous (i.e., without temporary rise) to the supposed minimum, nor is it likely to be so rapid as it has been since 1890; and in any case it would be difficult to fix, in advance, with much precision, the character of the individual winters covered by it. But at least it seems probable that, for a good many years to come, we shall not be visited with such an accumulation of cold as that in the ten years about 1890.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

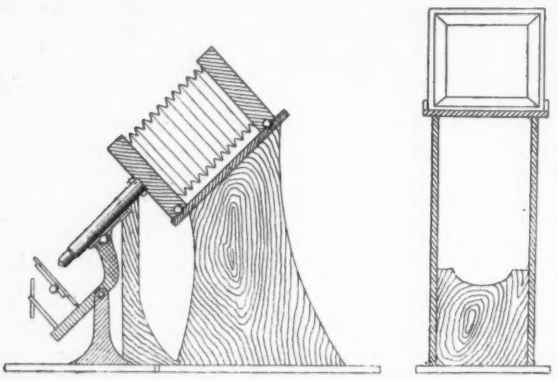
MICRO-PHOTOGRAPHY is now used by microscopists so extensively for educational, medical, and other professional purposes, that we propose to incorporate in these columns notes on new apparatus and methods dealing with this branch of microscopy. We shall therefore be pleased to hear from readers interested in the subject, and shall be glad to receive from them notes of any improvised laboratory, apparatus, or devices in manipulation that they may have adopted. Such apparatus and devices are frequently of real practical value, but being, perhaps, obviously simple to their originator, it does not occur to him that they may be of use to his fellow-workers.

Micro-photography is one of the simplest and best methods known for making permanent records of microscopic studies. It is not, however, so universally used as it should be, and this, not so much for the few difficulties that it offers, as on account of the mistaken ideas as to the cost of the apparatus required. Good work may be done by a patient and skilful manipulator with an ordinary camera, or any other makeshift arrangement; but such good work would, in all probability, be rendered still more valuable by the use of apparatus specially designed for the work. The question of cost can no longer be considered seriously as an obstacle to its practice.

There are now several makers who are prepared to sell well-made cameras for photo-micrographic work at prices considerably less than the cost of an ordinary camera. Messrs. Griffiths, Highgate Square, Birmingham, have a particularly good apparatus, consisting of a well-made bellows camera, extending from twelve to thirty inches, and attached to a neat base, carrying camera, microscope, and condensers. The object is readily focussed in any position by means of a long, adjustable brass rod which is attached to, and runs the whole length of the camera, and which is connected with the milled head of the fine adjustment screw of the microscope by means of a silk thread passing over a grooved wheel at the end of the rod. It is made in half-plate size with carriers for smaller-sized plates, and its price places it within the reach of all.

The photography of living bacteria and other cultures cannot be successfully accomplished with a horizontal camera. The

use of an upright apparatus is the best, but it is open to many objections, chief among which are its instability, the difficulty of focussing, and the fatigue it occasions the operator. Mr. Brightman, Colston Street, Bristol, has devised a useful and substantial support (*see* Fig.), which overcomes these difficulties,



Side Elevation *Back View*

and enables the photographer to successfully operate with his apparatus at an angle of 45° to the vertical. The arrangement is a good one, and is already in use in medical circles in Bristol.

One important habit which the microscopist should cultivate is that of making copious notes of observations. He should never be without his memorandum or note book. No more profitless work can be imagined than collecting natural history specimens and material without some specific aim or object. Every observation made should be carefully recorded, and the date of capture, locality, and, where possible, the food-plant, should always be attached to the specimens when these are mounted. For field memoranda the use of a stylographic pen is advisable, as pencil writing is apt to rub and efface in time by the motions of the body. A larger record book for more extended notes should be kept at home for biological details. When studying insects, for instance, notes on adolescent states, which it is intended to rear to the imago, cannot be too carefully made, or in too much detail. The relative size, details of ornamentation and structure, dates of transformation from one state to another — indeed everything that pertains to the biography of the species—should be noted down, for where exact data are so essential, little or nothing should be trusted to mere memory.

In photographing wood sections without a lens, Herr Fomm places a piece of tinfoil on one side of the section and the film surface of a piece of bromide paper against the other side. A good impression—showing clearly the rings and rays of the wood—is produced in about a half a minute when a metallic point negatively charged by an influence machine is brought within two inches of the paper. It is explained that the paper becomes negatively charged, and a photographically active glow-light is produced between it and the wood. It is proposed to try this method for copying drawings and for other purposes.

Mr. F. R. Rowley gives some valuable hints on the collection and preservation of diatoms in a recent issue of *Natural Science*. In collecting, a spoon attached to a stick may be used for skimming the brown diatomaceous ooze off the surface of the mud; a drag net serves this purpose in the case of forms occurring at greater depths, e.g., *Surirella*. The latter should be placed with water in shallow glass vessels sheltered from direct sunlight. The diatoms will appear in masses on the surface of the mud after twelve hours. Transfer them by means of a pipette to the fixing fluid. Fleming's chromo-aceto-osmic acid, and sublimate, in aqueous or alcoholic solution, is recommended as being the best reagent for demonstrating the delicate structural features of the nucleus and cytoplasm during division. The chromatic elements of the nucleus are well shown by picro-sulphuric acid followed by hæmatoxylin. The arrangement of the cytoplasm, the chromatophores, and other inclusions in the cell may be well brought out, in unstained preparations, by a one per cent. osmic acid solution. A solution of iodic alcohol (45 per cent.) is recommended for the study of the so-called "red granules" of Bütschli, which, by the foregoing method, stain well after fixing.

Large forms receive a somewhat different treatment. They are removed individually with the aid of a capillary tube and a dissecting microscope, and are transferred to the fixing bath. The solution is decanted off after fifteen minutes and the objects are passed through water and alcohol, of strengths increasing to the absolute point. This extracts oil and the colouring matter of the chromatophores. The preparation is then passed through alcohols of decreasing strength into distilled water, after which it is stained in a weak solution of Delafield's hæmatoxylin. The material is then passed successively through 35, 70, 95 per cent. and absolute alcohol into clove oil and finally mounted in dammar.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* Knowledge.]

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

No new comet has been discovered during the last three months. Giacobini's comet (first seen on September 29th, 1899) is now invisible, and Holmes's comet some time since passed beyond the range of ordinary instruments. An ephemeris by Zwiers is given in *Ast. Nach.* 3610, and from this it appears that the position of Holmes's comet on February 5th, 1900, will be R.A. 2h. 40m. 40s., Dec. + 39° 14′ 37″, or about 5 degrees west of β Persei (Algol).

Finlay's Comet.—This object was discovered in September, 1886, at the Cape of Good Hope, and it was soon found to be moving in an elliptical orbit, with a period of little more than six and a-half years. Mr. Finlay redetected the comet in July 1893, and it is now again near its perihelion, but M. Schulhof, of Paris, has recently investigated the orbit, and finds that the comet is not likely to be seen before 1906. In August of that year it will be comparatively near to the earth, the distance separating the two bodies being less than 20 millions of miles.

The Shower of Leonids in 1899.—The comparative deficiency of meteors at the middle of last November has led to the suggestion that the position of the stream may possibly have been disturbed by planetary attraction. Though this particular shower has been irregularly providing us with brilliant displays during the last thousand years, there is certainly evidence to show that the meteor-group has been sufficiently disturbed to enable it to pass almost clear of the earth. From computations undertaken by Dr. Downing and his assistants at the *Nautical Almanac* Office, it appears that the large planets Jupiter and Saturn have exercised considerable influence upon the orbit of the swarm which visited us in 1866, and that at its return in 1889 it must have passed about 1,300,000 miles inside the earth's orbit. Next year the conditions will be still more unfavourable, whence, if the theoretical deductions are quite reliable, there will be a poor display, unless the meteors are richly dispersed in a direction away from the sun. Indeed, the opinion seems gaining ground that the shower is practically lost to the present generation of observers. There is, however, sufficient doubt in the matter to encourage the hope that the meteors may reveal themselves either in 1900 or 1901, and particularly in the latter year. There was a fine display in 1868, though it was little expected. We have perhaps, in recent years, regarded our prospects of witnessing a bright reappearance of the phenomenon in too favourable a light, when all the circumstances are considered. At a single station the chances are always great that the shower will escape observation. During the last thousand years very few brilliant returns have been observed in England. Historical records do not furnish descriptions of showers in 1883, 1799, 1766, 1733, or in many previous years when the Leonid comet was probably near its perihelion. Had the event occurred some mention of it would certainly have been preserved. But notwithstanding prevalent doubts, and the failure of recent attempts, we should redouble our efforts to witness the shower in the two or three ensuing years, for even should it fail to present a conspicuous aspect, it will be possible to obtain negative evidence of a useful kind. It must be remem-

bered that displays took place in 902, 1002, 1101, 1202 and 1602, so that we need not despair of seeing the meteors until after the return of 1902, for exactly three periodical revolutions of the meteor group are completed in a century.

BRIGHT METEOR OF NOVEMBER 19, 1899.—At 8h. 5½m. a meteor, equal to Jupiter in apparent lustre, was seen by Mr. T. W. Backhouse at Sunderland, and by Mr. C. L. Brook at Meltham, near Huddersfield. It moved slowly and was yellowish-white in colour. The paths indicate a radiant at 60° + 28° on the northern boundary of Taurus, near the star Psi. At its first appearance the meteor was about 85 miles high, over a point in the sea 40 miles east of Hornsea, on the Yorkshire coast. When it disappeared it was 42 miles over Driffield, and had completed a path of 68 miles in three seconds.

FIREBALL VISIBLE IN SUNSHINE, JANUARY 9, 1900.—At 2h. 55m. p.m. on January 9 last, when the sun was shining brightly in a cloudless sky, a fireball of remarkable size and lustre was seen at many places in England. Descriptions of its appearance have been received from Brighton, Eastbourne, Lewes, and Worthing (Sussex), Penshurst and Beckenham (Kent), Guildford and Reigate (Surrey), and other places. All the observations come from the S.E. region of England. A preliminary reduction of the materials indicates that the radiant was situated between Aquila and Sagittarius, and that the fireball descended from 59 to 27 miles during its flight of about 140 miles over the English Channel. Its motion was very rapid, and the general direction of its observed course from S.W. to N.E. This phenomenon reminds us of the large meteor which passed over Lancashire and Yorkshire on February 8, 1894, at 28 minutes after noon.

THE METEORS OF BIELA'S COMET.—In our last month's "Notes" it was mentioned that the astronomers of the Vienna Observatory counted 67 meteors, most of which were from Andromeda, on the evening of November 23rd. From a communication in *Ast. Nach.* 3612, it appears that observations were continued on November 24th, when 240 meteors were seen in the five hours ending 10h. 30m. The maximum occurred at 8h., when the horary rate of apparition was about 80.

THE JANUARY QUADRANTIDS.—Prof. A. S. Herschel, of Slough, obtained a very successful observation of these meteors on the night following January 2nd, 1900. Between 11h. and 16½h. he saw 130 meteors, and registered the paths of 80 of them. The Quadrantids furnished about four-fifths of the total number seen. During the night two very fine meteors were recorded as follows:—

Time 14h. 58m., Mag. 3 × ♀, Path 95° + 50° to 87° + 38°.
„ 16h. 17m., „ = ♀, „ „ 35° + 52° to 45° + 40°.

Mr. W. E. Besley, of Clapham Common, S.W., also watched the progress of this shower on January 2nd. Between 11h. 38m. and 13h. he counted about thirty meteors, and nearly half of these were Quadrantids, with a radiant at 230° + 54°. At 11h. 59m. he registered a 1st magnitude meteor, which was also seen by Prof. Herschel at Slough. From a projection of the combined paths the radiant comes out at 228° + 53°, so that it was a true Quadrantid. The meteor fell from 57 to 40 miles, and had a length of path of about 44 miles, which it traversed in 2 seconds.

THE FACE OF THE SKY FOR FEBRUARY.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 7.41 and sets at 4.47; on the 28th he rises at 6.50 and sets at 5.36. Few sun spots are likely to be observed. Observers interested in the Zodiacal Light should keep a watch for it in the west during the early evenings.

THE MOON.—The moon will enter first quarter at 4.23 P.M. on the 6th, will be full at 1.50 P.M. on the 14th, and will enter last quarter at 4.44 P.M. on the 22nd. There is no new moon this month, according to the ordinary civil reckoning. Kappa Piscium, mag. 5.0, will be occulted on the 2nd; disappearance at 6.56 P.M. at 101° from the north point (65° from the vertex), reappearance at 7.43 P.M. at 210° from the north point (172° from the vertex). Delta Arietis, mag. 4.5, will be occulted on the 6th; disappearance at 8.36 P.M. at 127° from the north point (93° from the vertex), reappearance at 9.24 P.M. at 214° from the north point (175° from the vertex).

THE PLANETS.—Mercury will be in superior conjunction with the sun at 9 P.M. on the 9th, and will afterwards be an evening star. Towards the end of the month he will come into a favourable position for observation, setting on the 28th an hour and twenty-three minutes after the sun. He will then be in the south-western part of Pisces, away from bright stars; at 6.30 P.M. he will be about 8 degrees above the horizon and 6 degrees south of west.

Venus is an evening star, and will be a striking object in the western sky after sunset. At the middle of the month the planet crosses the equator and will then set about 8.30 P.M., eight-tenths of the disc being illuminated. The planet enters Pisces in the early part of the month and approaches the eastern part of that constellation towards the end.

Mars is too near the sun for observation.

Jupiter is a brilliant object in the morning sky. On the 23rd, at 4 A.M., he is in conjunction with the moon, and 1° 31min. to the north, the moon then being at nearly half phase. He is in quadrature with the sun at 6 P.M. on the 28th. About the middle of the month he rises shortly before 3 A.M. During the month he describes a short direct path in the most southerly part of Ophiuchus.

Saturn is also a morning star, rising on the 14th at about 4.37 A.M. During the month he describes a short direct path in the western part of Sagittarius.

Uranus is also a morning star, rising at the middle of the month about 3.6 A.M. He is in the southern part of Ophiuchus, nearly midway between Antares and Eta Ophiuchi and about 4° east of Jupiter at the middle of the month.

Neptune is an evening star, setting at the middle of the month about midnight. His path is a short westerly one through the Milky Way in Taurus; at the middle of the month he is 1° north of Zeta Tauri and three-quarters of a degree following that star.

THE STARS.—About 9 P.M., at the middle of the month, Ursa Major will be in the north-east, Arcturus rising in the north-east, Leo will be a little south of east, Cancer and Hydra in the south-east, Gemini and Auriga nearly overhead, Canis Minor and Canis Major near the meridian, Orion a little west of south, Taurus in the south-west, Aries and Perseus in the west, and Andromeda and Cassiopeia towards the north-west.

Convenient minima of Algol will occur at 10.57 P.M. on the 13th, and 7.46 P.M. on the 16th.

Chess Column.

By C. D. LOCOCK, B.A.

Communications to this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions for January Problems.

(J. T. Blakemore.)

No. 1.

1. Q to KB2, and mates next move.

[There is unfortunately another solution by 1.

Q to KKt6, this in fact being the solution discovered by almost all our correspondents.]

No. 2.

1. Q × P, and mates next move.

CORRECT SOLUTIONS of both problems received from E. Servante, Capt. Forde, Alpha, W. de P. Crousaz, G. C. (Teddington), J. W. Meyjes, W. J. Allen (both keys), H. Le Jeune, H. S. Brandreth, K. W. J. Baddeley.

BERNARD LINTON.—December solutions received too late to acknowledge. No. 1 is incorrect, as you may have seen.

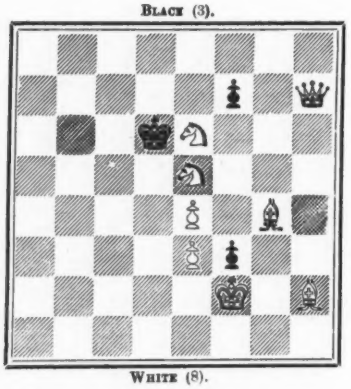
J. BADDELEY.—Nevertheless the solver, as you say, "has only himself to please"; and as it is better to read Homer with a translation, than not at all, so the solver who cannot master a problem from the diagram is justified in moving about the pieces. The question in fact must apparently depend on the solver's ability.

We revive below two ancient Problems well worthy of resurrection. Our solvers will not have such an easy time as they have had for the last two months.

PROBLEMS.

No. 1.

BLACK (3).

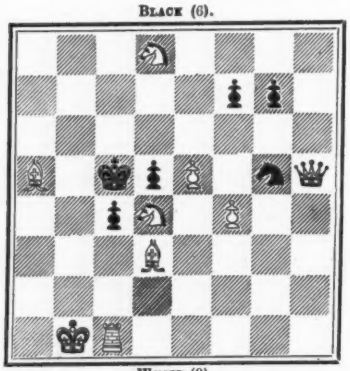


WHITE (8).

White mates in three moves.

No. 2.

BLACK (6).



WHITE (9).

White mates in three moves.

Both the above are by the late J. G. Campbell, one of the strongest players, as well as one of the ablest composers of the last generation.

CHESS INTELLIGENCE.

The Austro-Hungarian National Tournament at Vienna the prizes for which were bequeathed by the late Baron Kolisch, resulted in a victory for Geza Maroczy, who scored 9 games out of 11. The second and third prizes were divided between C. Schlechter and a new player named Brody. Alapin took the fourth prize, the other scores being Marco, Wolff, and Zinke 6, Kolve, 5, Popice, 4½, Albin, 4, Schwarz and Prock bringing up the rear. It is unfortunate that ill health prevented Charousek from competing. The next international tournament begins at Paris on May 15. The prize fund already amounts to 16,000 francs.

On January 13 Kent County gained a handsome victory over Hampshire by 11½ games to 4½, the match being in the first round of the Southern Counties' Chess Union Championship. This result points to a most gratifying improvement in the play of the Kentish team. Mr. Hart-Dyke defeated Mr. J. H. Blake at board No. 1.

At the City of London Chess Club, Mr. Lawrence still retains a strong lead with 8½ out of a possible 9. Mr. W. Ward has scored 8 out of 10, and Mr. Herbert Jacobs 7 out of 9. The remainder are beginning to tail off.

The death is announced of Dr. Max Lange, the well-known player and theoretician, at the age of 67. His name will always be remembered in connection with the Max Lange variation of the Guioco Piano opening.

The Northern Counties Chess Union has issued its new programme, which contains, among other items, a challenge to the Southern Union to a match by correspondence with 50 players aside, and a congress to be held in Manchester on Easter Monday.

A National Chess Union is also in process of formation, with the object of filling the place of the old British Chess Association, which has practically been defunct for many years.

The following has been sent to us for publication:—

TO THE CHESS EDITOR.

DEAR SIR,—We shall be extremely obliged if you will kindly announce to the readers of your Chess Column that we are distributing Copies of the Wall Sheet "Laws for the Regulation of Games played over the Board," being Part II. of the British Chess Code (Revised Edition). These are intended for use in Chess Clubs, Reading Rooms, Chess Resorts, &c. Should any any of your Readers desire this Wall Sheet, they are requested to send the Address of Club or Room in which Chess is played to the British Chess Company, Stroud, Glos., and a Copy will be sent without charge.

Yours faithfully,
THE BRITISH CHESS CO.

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